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FEBRUARY 1, 1947

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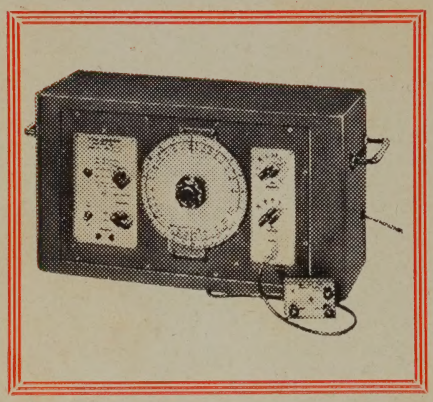

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RADIO and ELECTRONICS

Vol. 1, No. 11 February 1st, 1947

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OUR COVER:

The cover picture this month shows an F.M. "clover-leaf" antenna in the course of erection. Manufactured by the Western Electric Co., this aerial is designed to be non-directional in the horizontal plane, but possesses strong vertical directivity.

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GUY E. MILNE
ELECTRONIC TECHNICIAN

The Radio Servicemen's Examination

There are signs that, at the present time, more interest is being taken than ever before in the training of those wishing to pursue radio as a livelihood.

The necessity for such interest has been stressed before in this page, and the present-day shortage of trained technical personnel makes it more urgent than ever that the industry and the educational authorities should get together to produce a scheme whereby boys who wish to take up electronic work on leaving school can choose the school subjects best calculated to fit in with their post-secondary school requirements.

Theoretically, no doubt, this is possible already, but the figures from the last half-yearly Radio Servicemen's Examination indicate that, if so, there is still something wrong somewhere. Let us exemplify.

The examination referred to cannot be said to be of a high standard. This is not to be wondered at, since it is more in the nature of an insurance on the part of the Public Works Department against unauthorised and dangerous electrical wiring than anything else.

The examination consists of two written papers of two hours' duration. One deals with the theory of radio, and the other with the electrical wiring regulations. It is noteworthy that the examination does not include a practical test on the subject of fault-finding in radio receivers.

At the last examination, 167 men sat the paper in radio theory, and of these 72, or 43 per cent., passed. For the practical test (which is solely a matter of the electrical wiring of household fittings, etc.), 173 sat and 103, or 59 per cent., passed. In the written papers the pass mark is 50 per cent., and the average mark of those who passed was only 54 per cent. The examiner, commenting on the written papers, stated that only 18 candidates out of the 167 who sat obtained full marks in one of the compulsory questions, which was simply a matter of applying Ohm's Law and using simple arithmetic. Some candidates, also, did not have even an elementary knowledge of such a fundamental subject as the principle of diode detection.

To make matters worse, if possible, quite a number of those who passed (and failed) had already sat the examination several times before.

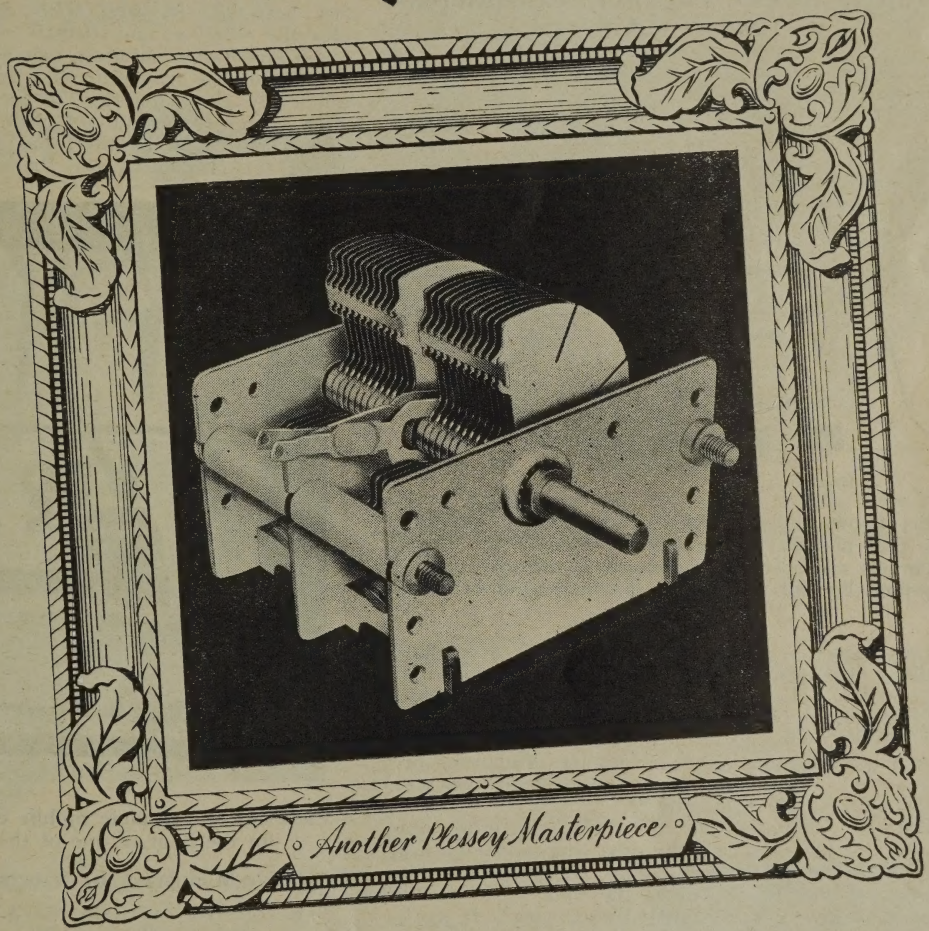
These figures bring to light a really deplorable state of affairs, in that so many men who consider themselves fitted to become radio servicemen cannot pass an examination which, as we said before, is of a very meagre standard technically. We do not contend that the mere passing of an examination, however high the theoretical standard, automatically labels the successful candidate as a good radio serviceman, but it cannot be going too far to say that a man who cannot work out a simple problem involving Ohm's Law, or who cannot understand in an elementary way the working of an essential part of a modern receiver, is unfitted to have valuable equipment placed in his hands on the understanding that he is able to place it in first-class working order.

One thing which helps to create this unsatisfactory situation is that anyone who can use a screw-driver and a soldering-iron is able, by following instructions, to build component parts into a radio receiver. It is therefore possible for a man to obtain a completely false idea of the extent of his knowledge of radio—which may even be nil. Such a man (and in the past there have been many) then gains the impression that he is fitted technically to take up radio servicing as a livelihood, whereas in many cases nothing could be farther from the truth.

The other most potent cause is the lack of appreciation of the fact that a sound knowledge of radio depends entirely on a solid grounding in elementary electricity and magnetism, as taught in the secondary schools, and in elementary mathematics.

Until this fact is brought home to prospective radio technicians, there will continue to be a large number of failures in the Radio Servicemen's Examination, and the standard of radio servicing in this country will remain at its present level.

PLESSEY *Variables*



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A Multi-carrier V.H.F. Communication System

By M. G. SCROGGIE, B.Sc., A.M.I.E.E., Consulting Radio Engineer, ex-Squadron-Leader, R.A.F.

Radio for mobile services, such as police and fire, is allocated V.H.F. bands because—

(i) The lower frequency bands are already overcrowded;
(ii) V.H.F. penetrates built-up areas better;
(iii) Small aerials radiate better at V.H.F.; and
(iv) Mutual interference between widely separated stations is prevented by the limited range.

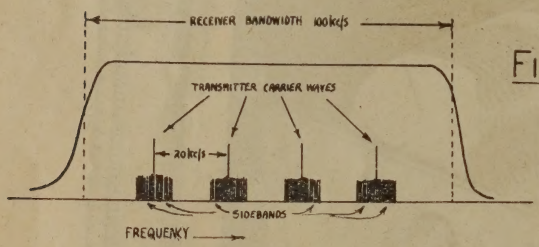


FIG. 1

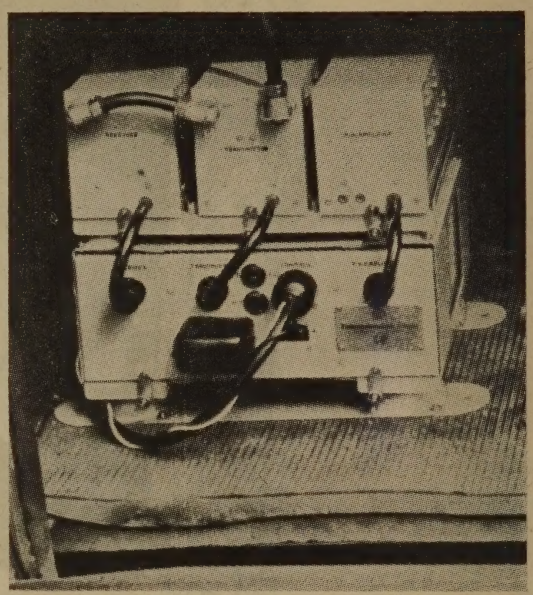
This shows how a wide-band receiver covers the four necessary channels simultaneously. The channels are spaced far enough to prevent overlapping, but all are within the pass-band of the receiver.

Unfortunately, in areas where there are many buildings, bridges, embankments, and other prominences, and in valleys—the very areas in which mobile radio communication is most wanted—coverage is very patchy, owing to shadows and destructive interference by reflected waves. Further difficulties are encountered when it is desired to extend the area served by a single transmitter.

Both for "illuminating" a small area more uniformly, and for enlarging the area served, the natural solution to consider is using more transmitters. The question then arises: should they all work on the same frequency or on different frequencies? If working on different frequencies necessitates retuning receivers, the idea can be dismissed at once. Apart from the inconvenience (police and firemen generally have plenty to think about without tuning a receiver) it is ineffective when in motion, because of the suddenness and frequency of fluctuations in field strength from any one transmitter. If the transmitters are to work on the same frequency, they must be exactly synchronised, which is difficult enough at much lower radio frequencies, and even if it could be perfectly achieved at V.H.F. there would be space phase troubles. Recent tests with frequency-modulated transmitters truly synchronised by a harmonically related linking frequency have in fact evinced such troubles.

One of the advantages claimed for frequency modulation is the "capture effect," by which the stronger of two transmissions takes charge of the receiver, even if the ratio of strength is not very great. All the same, unless the disparity in strength is assisted by terrain screening, there is a substantial area between the two transmitters where neither rules the receiver, and distortion is serious.

An alternative solution, using two or more amplitude-modulated transmitters working on frequencies sufficiently close together to be received simultaneously by receivers, but not close enough to interfere audibly with one another, has been developed and proved satisfactory by the British Government.



View of the complete mobile equipment installed in the boot of one of the patrol cars.

Amplitude-Modulated In Synchronism

The receivers used in the development tests had a band width of about 100 kc/s, and could therefore receive several carrier waves spaced at 20 kc/s intervals (Fig. 1). These carrier waves are amplitude-modulated in synchronism, and it is found that the phase differences resulting from the differences in distance from the transmitters do not cause noticeable distortion. The probability of the receiver aerial being in a dead spot is very greatly reduced even with only one additional transmitter radiating from a different site, and instead of reception fluctuating violently when in motion, it is comparatively uniform. With three transmitters the uniformity is still greater.

Service within an area is therefore vastly improved. Moreover, by spacing transmitters at suitable intervals, the service area can be enlarged indefinitely.

A travelling car comes within the influence first of one transmitter and then of another, but it is not evident which is contributing most at any one

'Dynaflare' 'Dynaflex' 'Dynaphon'

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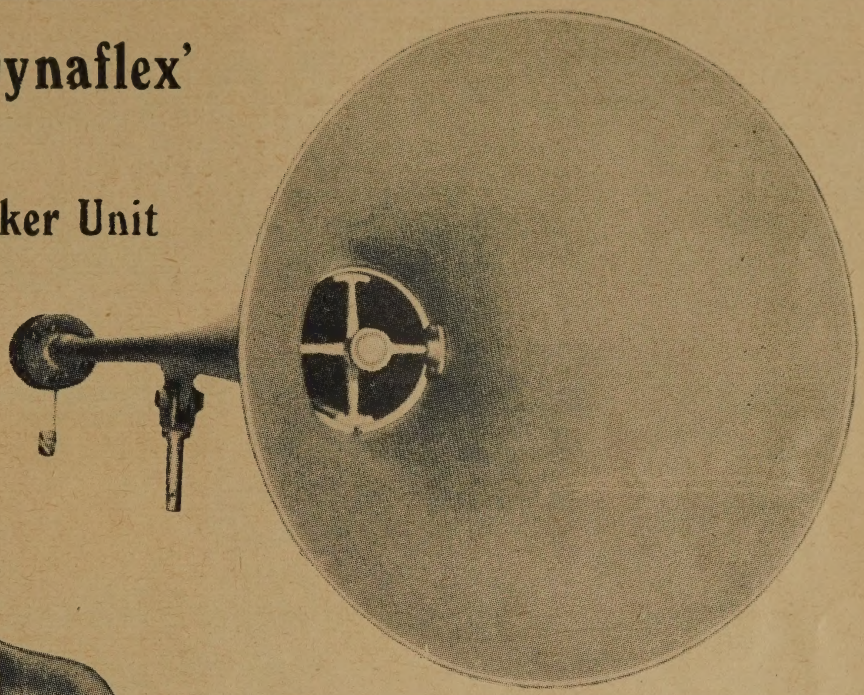

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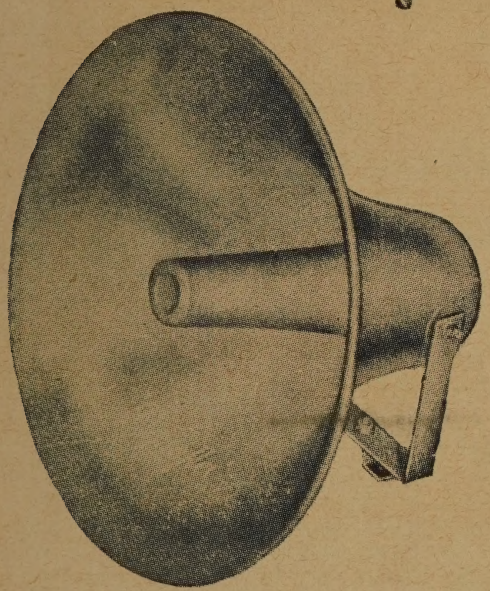

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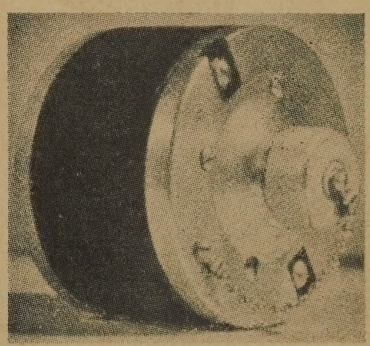

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moment, or when there is a change-over. The effort is somewhat analagous to diversity reception, and is sometimes called (not strictly accurately) diversity transmission.

A form of diversity reception is, however, used for communication in the reverse direction, from the mobile station, which of course cannot readily operate several spaced transmitters simultaneously. Instead, its single transmitter is picked up at the several fixed stations, and the results combined.

A three-carrier system of this type, covering the mainly rural and rather hilly area of three English counties, has been given extensive field trials, described in a paper before the Institute of Electrical Engineers by J. R. Brinkley. The details of the system are shown in Fig. 2, from which it will be seen that radio links are used to connect the three transmitting stations and the control centre. Land lines could be substituted if more convenient. The f3 receiver at the Master Control station and the f5 receivers at the Satellites are normally kept switched on. When the former receives a carrier wave from Area Control, the trigger circuit switches on the other transmitters. These in turn switch on the transmitters and the f2 receivers at the Satellites. The speech for the 100-watt transmitter at the Master Control is picked up by a receiver in the same way as at the Satellites, with the object of equalising phases by having the same chain of equipment for all three outgoing routes. This refinement was not extended to the incoming chains in the tests described.

FIG. 2

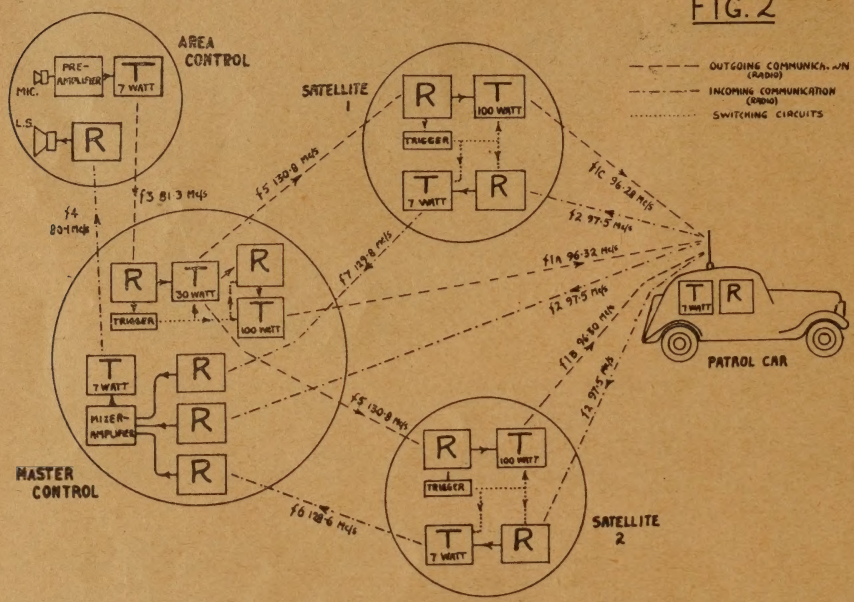

Diagram showing the lay-out of the multi-carrier system. The satellite stations enable communication to be maintained between patrol car and headquarters, even when the two are not in direct line of sight of each other.

Two-Carrier System In Greater London

A two-carrier system covering the greater London area has also been demonstrated.

In both cases the service was a great improvement, in respect of uniformity of signal strength, on signal-carrier systems, using either amplitude or frequency modulation. A nearly constant signal level was obtained over the whole of the two areas, in spite of the artificial and natural screening offered by the largest built-up area in the world and by the Chiltern valleys respectively. In addition, the three-carrier waves covered a larger area than any single station could have done, in spite of the station spacing not being ideal.

It may be noted that the frequencies used, which are in the bands allocated for such services in Britain (78.5—82, 95.5—100, and 128—131 mc/s), are much higher than the American police band (30—40 mc/s). There are several advantages in this. First, the higher frequencies penetrate streets, steel-framed buildings and tunnels better, in much the same way that waves higher than a certain critical frequency pass along waveguides while lower frequencies are rapidly attenuated. They are also less subject to electrical noises from trams, trolley-buses, etc., and are entirely free from long-distance interference, to which the lower frequencies are liable. For example, American police messages have often been heard in Europe. The experience gained in developing these high frequencies was of great value during the war, when their adoption by the British for aircraft communication was an outstandingly successful innovation.

It is claimed for frequency-modulation, generally favoured for V.H.F. in America, that it is much freer from thermal and ignition noise, so giving both a better service, and one usable down to lower field strengths and therefore at greater ranges. V.H.F. range is limited more by propagation characteristics than by over-riding noise, however, especially at frequencies higher than those used in the U.S.A.; and the multi-carrier amplitude-modulated system enables range to be extended indefinitely by adding transmitters of moderate power without increasing the number of frequency channels occupied. H. Stanesby, in connection with the I.E.E. paper already mentioned, shows how an unlimited area might be covered by transmitters working on only three-carrier frequencies, so arranged that the nominal service areas of any two stations on the same frequency

(Continued on page 46.)

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A FOUR BAND AMATEUR'S TRANSMITTER

The average amateur, having once obtained his high frequency permit, likes to be able to change rapidly from band to band, as conditions dictate, so that he requires a high degree of flexibility in his transmitting equipment. In this article is described a transmitter which largely fulfils these requirements.

Many amateurs are of the opinion that a multi-band transmitter becomes relatively inefficient on the higher frequency bands, and so prefer separate transmitters, but for those who find space at a premium, and whose pockets are of limited capacity, the band-switching transmitter allows a very real saving in both these directions, while giving excellent performance on all bands.

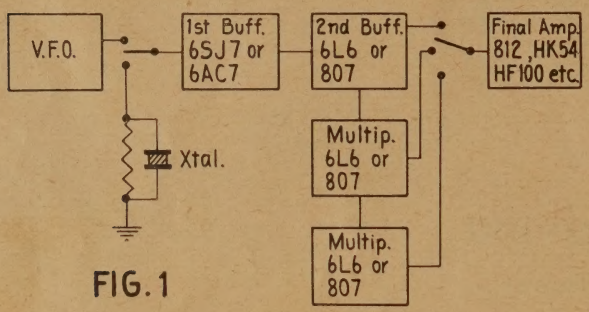

FIG. 1

The block diagram of the transmitter, showing the general scheme used for obtaining four-band operation, either on xtal control or V.F.O. control.

POWER OUTPUT

As presented here, the transmitter is capable of taking the full 100 watts input on 80, 40, 20 and 10 metres, but for those who consider the high power final amplifier and its associated high-voltage power supply beyond their scope, the final may be omitted, and the multipliers will still provide a very useful power output on all bands.

GENERAL ARRANGEMENT

The block diagram, Fig. 1, illustrates the valve line-up used. It will be noted that provision is made for using either a crystal or a variable frequency oscillator. In view of the considerable, and no doubt increasing, QRM on most of the amateur bands, the need for a really stable V.F.O. is becoming greater, and this type of frequency control is worthy of more consideration than it has been given in the past. One of its advantages is that it allows of a practice which is at once helpful in maintaining contacts and in reducing interference—that of the called station replying on as close a frequency as possible to that used by the caller. This ensures that the entire QSO which follows occupies only one channel.

THE V.F.O.

There are a number of V.F.O. circuits which provide a good stable signal, and one of the best of them is the Franklin, which is used here. With this circuit, if some care is taken over the making of a good mechanical job, the frequency stability is little poorer than that of most crystals, and without doubt better than many.

The circuit diagram gives all the component values, and if these are adhered to, there should be no trouble in making the oscillator operate satisfactorily. It is most important to construct the oscillator tuned circuit with considerable care, using only the best components. The condensers C_3 and C_4, in particular, should be of the highest quality, possessing extreme rigidity of construction. It is a good plan to build C_3, C_4, L_1 and the two small condensers C_1 and C_2, into a separate compartment which may be rubber-mounted on the main chassis. This precaution minimises the possibility of frequency modulation through mechanical 50-cycle vibration from the power supplies.

CLASS A BUFFER

A further somewhat unusual feature of the line up is the 6AC7 or 6SJ7 buffer stage. This is operated as a Class A amplifier, when the V.F.O. is in use, or as a crystal oscillator. The purpose of providing alternative crystal operation is to allow for those who prefer this type of control, especially when doubling or quadrupling to the higher bands, and also to comply with the regulations, which state that crystal control **must** be used on 20m. 'phone.

When the V.F.O. is in use, a Class A buffer is a very good thing, since it draws negligible power from the oscillator, and reduces to an absolute minimum any variation of frequency due to differences in the loading on the oscillator. This stage provides ample drive for the 807 second buffer.

SECOND BUFFER AND MULTIPLIERS

The second buffer works as a straight amplifier at all times, with its input and output circuits tuned to the 80-metre band. Its output goes to the wave-change switch, and also to the grid of the first multiplier. The output of the latter is connected in a similar fashion to the input of the second multiplier, and also to the wave-change switch. The latter includes contacts in the cathode circuits of the multipliers, so that these may be brought into operation by the switch, and do not pass plate current when they are not required to operate. The plate tank circuit of the first multiplier is so proportioned that it will tune to either 40 or 20 metres, while in the same way, the second multiplier tank circuit tunes to either 20 or 10 metres. Operation on the various bands is as follows:—

80 Metres:

The second buffer feeds straight through to the final, while both multipliers are inoperative.

40 Metres:

The second buffer operates at 80m., and the first multiplier is switched in with its plate tank tuned to 40 metres.

20 Metres:

The second buffer works at 80 metres, the first multiplier at 40, and the second multiplier is switched in, with its plate tank tuned to 20 metres.

10 Metres:

The second buffer works at 80 metres, the first multiplier quadruples to 20 metres, and the second multiplier doubles to 10 metres.

THE FINAL AMPLIFIER

The final in the transmitter described is an 812, but an HK54 or other tube of similar rating and capable of operating down to 10 metres would do equally well. The values shown on the circuit diagram refer, of course, to the 812, but it should not be necessary to alter any values other than those of the grid-leak and cathode resistors if a different tube is used.

V.F.O. CIRCUIT

C_4 is the front panel control of the V.F.O., and has a maximum value of 25 mmfd. C_3, the band setting condenser, has a value of 100 mmfd. max. If it is desired to spread the 3.5–4 mc/sec. band over the whole of the tuning dial, the coil L_1 should be wound so that 3.5 mc/sec. comes at the closed end of the tuning condenser with 75 mmfd. of the band setting condenser in use. If this state of affairs is achieved, complete bandspread will be obtained. If somewhat less bandspread is desired, the coil should have fewer turns, so that more than 75 mmfd. of the band setting condenser is in use to bring the low

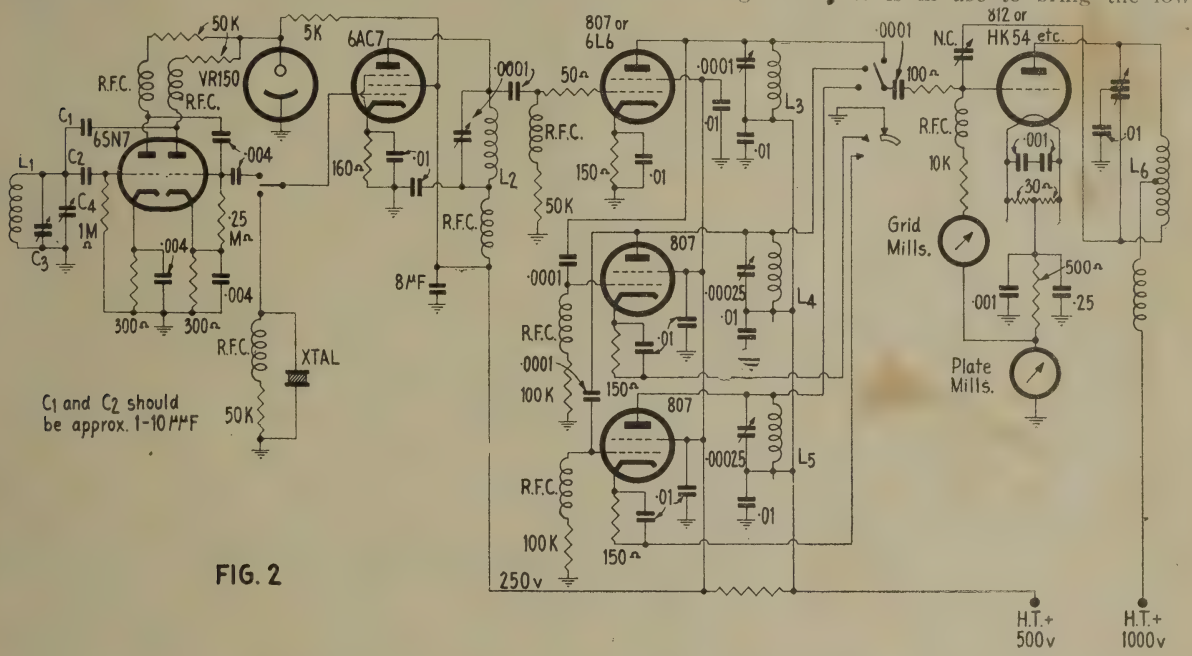

FIG. 2

Complete circuit of the transmitter, with all the necessary constants. Note the method of connecting the meters in the final in such a way that they read only grid current and plate current respectively.

The final uses plate neutralisation, and its grid bias is obtained partly by grid leak and partly by cathode biassing. With the values shown, there may be slight difficulty in obtaining rated grid current on the 10m. band, in which case the grid-leak could be reduced in value, down to the manufacturer's quoted figure of 4,000 ohms.

TUNED-CIRCUIT VALUES

In general, we have avoided specifying particular coils with the size of former, winding pitch and number of turns, etc., because many amateurs have their own ideas about just what sizes and shapes of coil they should use for a given purpose, and this again is often partially determined by the mechanical construction of the transmitter. However, the important quantities with respect to the tuned circuits are the maximum capacities of the tuning condensers, and these have been given in all cases. The constructor can then please himself as to the exact coil construction used.

frequency end of the band into position on the tuning condenser.

FIRST AND SECOND BUFFER TANKS

Both these circuits are tuned with 0.0001 mfd. condensers, and tune only to the 80m. band. The coils should be such that the low frequency end of the band is tuned with about 75 mmfd. of the condensers in use. L_2 can be very small, since it handles very little power—less than two watts.

MULTIPLIER TANKS

The condensers here are of 0.00025 mfd. maximum capacity. These may seem large, but are necessarily so in order that both the 40 and 20m. bands may be covered by the first multiplier, and 20 and 10 metres by the second. Since ample driving power is available, undue consideration of L/C ratios in these circuits is not necessary. L_4 and L_5 should be wound so that the low frequency bands (40 and 20m. respectively) should come near the maximum capaci-

ties of the condensers. In the transmitter we are describing, L_4 was wound with 8 turns of 16-gauge enamelled wire, close-wound on a 1½ in. former. L_5 was 5 turns of the same wire, double-spaced on a similar former.

FINAL PLATE TANK

The split stator condenser is one of 100 mmfd. max. per section. Typical coils for the four bands are:—

Diameter, 2½ in.; **Wire,** 16 gauge; **Pitch,** Double-spacing.

80m.—32 turns.
40m.—18 turns.
20m.—8 turns.
10m.—4 turns, spaced out somewhat.

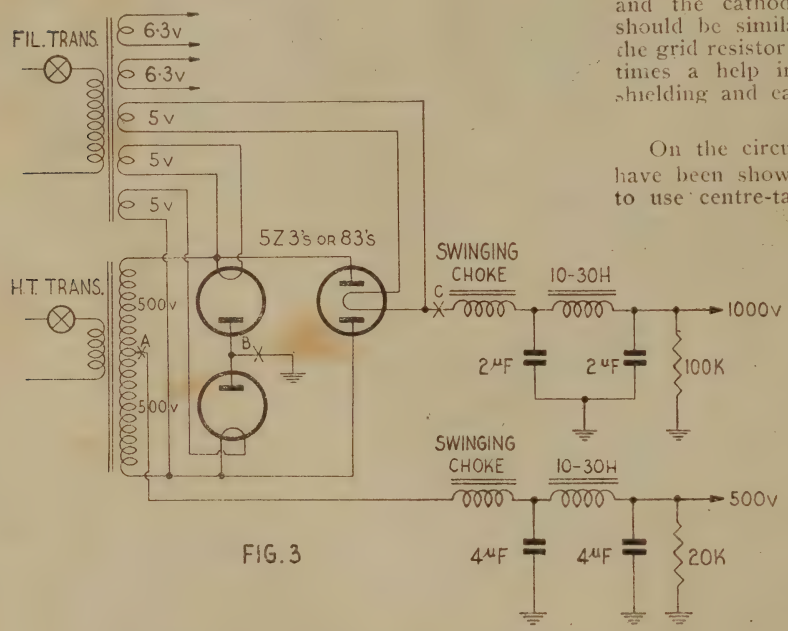

FIG. 3

Needless to say, these figures need only be taken as typical, and any well-made coils wound to suit the tuning condenser may be employed.

POWER SUPPLY

The chokes have both been indicated on the circuit diagram as "swinging." As far as the high voltage supply is concerned, this kind of choke has the advantage that with it, a high resistance bleeder may be used, and that the regulation of the supply when the transmitter is being keyed is much improved. A further advantage is that the peak voltage on the first filter condenser is considerably reduced, so that a lower-rated component may be used. A swinging choke is again an advantage in the 500 volt supply, since the current drawn from it varies considerably according to how many of the multipliers are in circuit. Because of this, the voltage delivered by the supply varies also. It is because of these variations that a VR tube to feed the Franklin oscillator is absolutely essential. If the variations in the 500v. supply are too great, there is a danger of the VR tube not being able to cope. If it should lose control, through becoming unstruck, quite noticeable frequency shift will occur in the oscillator. However, normal chokes of about 20 henries inductance with the maximum D.C. passing through them should give quite good performance, particularly if 83's are used as rectifiers. These tubes will give better regulation than will 5Z3's.

MODULATOR

The modulator used with this transmitter is almost identical with the one described in the August, 1946, issue of "Radio and Electronics," and thus requires no further description.

If the modulator is in close proximity to the R.F. unit, trouble may be experienced on 10 metres through R.F. getting into the early stages of the modulator. The heaters of these tubes should be by-passed with small mica condensers, say, 50 mmfd., and the cathode resistors and plate-load resistors should be similarly treated. Reducing the value of the grid resistor belonging to the initial stage is sometimes a help in this direction. Of course, good shielding and earthing are essential.

KEYING

On the circuit diagram, no keying arrangements have been shown. It would be possible, of course, to use centre-tap keying in the final stage, prefer-

Figs. 3 and 4 show the power supply arrangements for the transmitter. Note that both 1000v. and 500v. are obtained from the one H.T. transformer by the use of a bridge rectifier system, using three 5Z3's or 83's. The two left-hand ones on Fig. 3 are operated with their plates tied together.

Fig. 4, below, shows an alternative smoothing arrangement using only one pair of chokes in the negative lead, which is common to both supplies. The points A, B, and C on both figures indicate the points at which the smoothing arrangement of Fig. 4 should be attached to the rectifier system if it is to be used instead of the arrangement in Fig. 3.

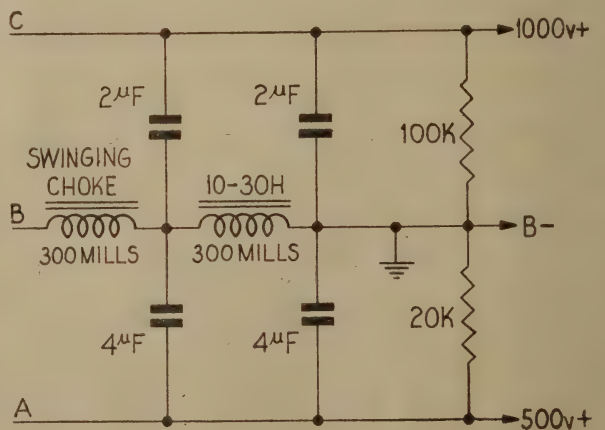

FIG. 4

ably through a keying relay, on account of the dangerous voltages involved, and certainly with the inclusion of a suitable key-click filter.

An alternative arrangement would be to key the cathode circuit of the 807 second buffer stage. This introduces no complications, as the second buffer is in use on all bands. Here again a key-click filter is a necessity, and a keying relay advisable.

There is a considerable advantage to be gained by keying the buffer, since, in this case, the cathode resistor of the final amplifier can be adjusted so that its plate current at zero excitation is as close as possible to the value obtained with full excitation and loading. It will not be possible to allow the final to draw its full 100 ma. with no excitation, since the plate dissipation rating will be exceeded.

Since the maximum plate dissipation of the 812 is 55 watts (I.C.A.S.), this gives a maximum plate current of 55 ma. under key-up conditions. The cathode resistor can be adjusted by trial and error to give this value of plate current. Arranging things in this way will noticeably improve the plate supply regulation on C.W.

AERIAL ARRANGEMENTS

On the circuit diagram, aerial coupling arrangements have been omitted advisedly, as has any description of tuning-up the transmitter and general operating data. This transmitter is not exactly one for the beginner to tackle, so that detail of this kind is hardly required.

ZC.1 Conversions

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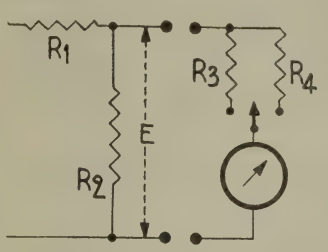
ACCURATE VOLTAGE READINGS IN HIGH IMPEDANCE CIRCUITS

Although in these enlightened times no one thinks of using a D.C. voltmeter of fewer than 1000 ohms/volt, there are many situations where such a meter has too low a resistance to be used without upsetting the voltage to be measured, and giving a wrong answer. In some cases, a cure is to use, say, a 20,000 ohm/volt meter, but such an instrument is not always available.



However, a method whereby two readings has been worked out taken on different ranges of a (comparatively) low resistance multimeter may be used to arrive at the true voltage which exists at the point of measurement, when no shunting exists due to the meter circuit, i.e., when the meter is removed.

Suppose it is required to measure the voltage E across R_2 in the circuit. The meter is shown with two series resistors R_3 and R_4, representing the total resistance of the meter on two of its available ranges. One of these resistances is higher than the other, but both are too low to leave E unaffected when the meter is clipped across R_2. Let us suppose that E_1 is the meter reading in volts on the higher of the two ranges, and that E_2 is the meter reading on the lower range. In addition, we must know S, which is the ratio of the full-scale readings on the two ranges.

Then, the true voltage E, is given by the formula:

$$E = \frac{(S-1)E_1}{S - \frac{E_1}{E_2}}$$

For example, suppose we are using the 50 and 100 volt ranges of the meter. In this case, the formula would reduce to

$$E = \frac{E_1}{2 - \frac{E_1}{E_2}}$$

Supposing further that on the 100 volt range, the reading is 60 volts, and that on the 50 volt range the reading is 40 volts. Thus, $E_1 = 60$, and $E_2 = 40$, and we have

$$E = \frac{60}{2 - \frac{60}{40}} = 120\text{v.}$$

It is clear that for the most accurate results from this method, the meter should give a reasonable scale deflection on both of the ranges used. A suggested method of carrying out such a measurement is to connect the meter in the circuit, but on the higher possible range. Then, use the range switch to find the two ranges most suited to taking the readings. The best two ranges will usually be the highest that allow a reasonable deflection to be obtained.

It should be noted that any errors in reading E_1 will be multiplied after the formula has been used, so

(*Continued on page* 48)

TUBE DATA

THE EBC33 DUO-DIODE-TRIODE

General:

The EBC33 is the octal-base version of the EBC3, with which it is exactly equivalent, except for the inter-electrode capacities. Valve dimensions and the basing diagram are given in Fig. 1.

The EBC33 triode section has an amplification factor of 30, a mutual conductance of 2 ma./v., and a plate resistance of 15,000 ohms. It is thus very well suited for use either in resistance or

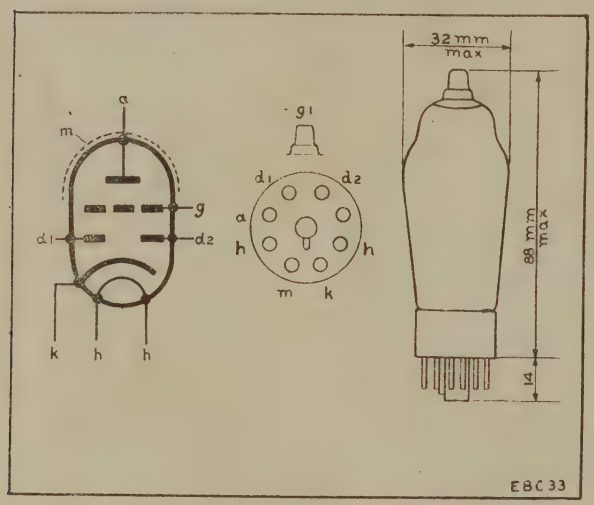


Fig. 1

transformer coupled circuits, and will give particularly high stage gain with the latter.

Most triodes with an amplification factor as high as 30 have too high a plate resistance to make them very suitable for transformer coupling, but this is not the case with the EBC33. Its plate resistance of 15,000 ohms is little higher than that of the average triode with an amplification factor of up to 20.

The diodes may be used in the usual way for detection and automatic gain control. The table of characteristics gives certain limiting data in addition to the usual operating information. It will be noted that the maximum grid voltage is —1.3v., at which value a grid current of 0.3 μa. flows. This figure is useful in using the characteristic curves of Fig. 2 to estimate the maximum signal voltage output. Fig. 2 gives the mutual characteristic for four values of plate voltage. It should be noted that operation at plate voltages below 150 will not give particularly distortionless amplification unless the signal input voltage is confined

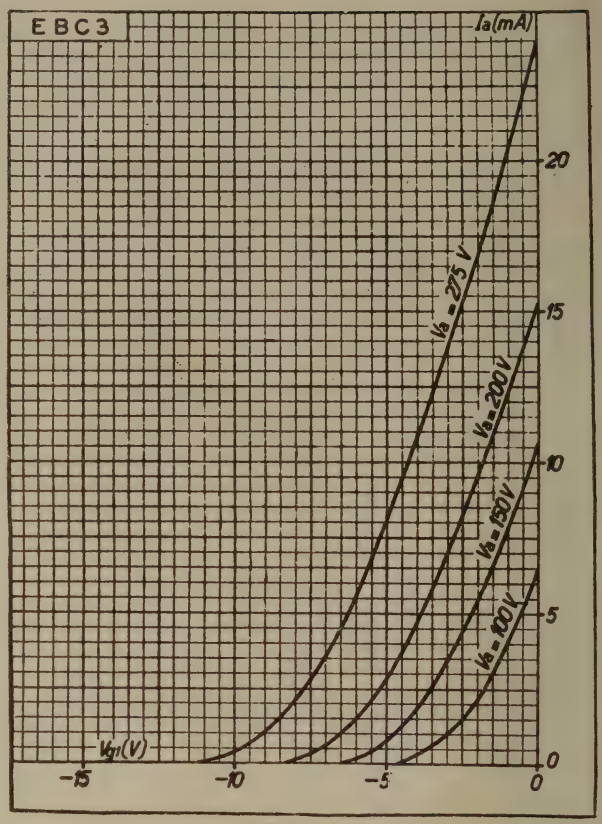


Fig. 2

to very small amplitudes.

ELECTRICAL CHARACTERISTICS

1. **HEATER:** Indirect heating A.C. or D.C.
   - Voltage ..... 6.3v.
   - Current ..... 0.2 amps.
2. **CAPACITIES:**
   - $C(k - d_1)$ ..... 1.9 mmfd.
   - $C(k - d_2)$ ..... 2.5 mmfd.
   - $C(d_1 - d_2)$ ..... Less than 0.5 mmfd.
   - $C(g - d_1)$ ..... Less than 0.005 mmfd.
   - $C(g - d_2)$ ..... Less than 0.005 mmfd.
3. **OPERATING CONDITIONS AS TRANSFORMER-COUPLED AMPLIFIER:**

Plate voltage	100v.	200v.	275v.
Plate current	2 ma.	4 ma.	5 ma.
Grid voltage	—2.1v.	—4.3v.	—6.25v.
Amplification factor	30	30	30
Mutual conductance	1.6 ma./v.	2 ma./v.	2 ma./v.
Plate resistance	19000 ohms	15000 ohms	15000 ohms

4. **LIMITING VALUES:**
   - Maximum plate voltage 300v.
   - Maximum plate dissipation 1.5w.
   - Maximum diode plate voltage 200v.
   - Maximum diode current 0.8 ma.
   - Maximum cathode current 10 ma.
   - Maximum grid voltage —1.3v.
   - Maximum grid-plate resistance 1.5 megohms
   - Maximum grid-cathode resistance 1 megohm
   - Maximum cathode-heater resistance 20k.

MORE ABOUT THE ZC1

By RALPH SLADE, ZL2BK

The following notes should prove of considerable interest to those who wish to modify the ZC1 for A.C. operation and to give higher transmitter output. ZL2BK has made a particularly thorough study of the problems involved in both these modifications, and we have no hesitation in recommending his findings to the attention of interested readers.

THE RECEIVER

It is a very simple matter to remove the complete vibrator unit and to substitute in the same space an A.C. power pack. The power pack consists of a transformer having a high voltage centre-tapped secondary wound for 370-0-370 volts, and a 12 volt heater winding. The high voltage secondary is fed to two 6X6GT rectifiers (one in each leg with the plates of each tube paralleled). The rectified secondary voltage is connected to the normal H.T. lug underneath the chassis, from which it passes through the filter network as before.

The following precautions are necessary:—

(a) If the A.C. mains are fed into the ZC1 via the normal 12 volt input plug-socket (or substituted plug-socket), it is advisable to remove condenser C14C which normally bypasses the original 12 volt positive to chassis. C16M should also be removed.

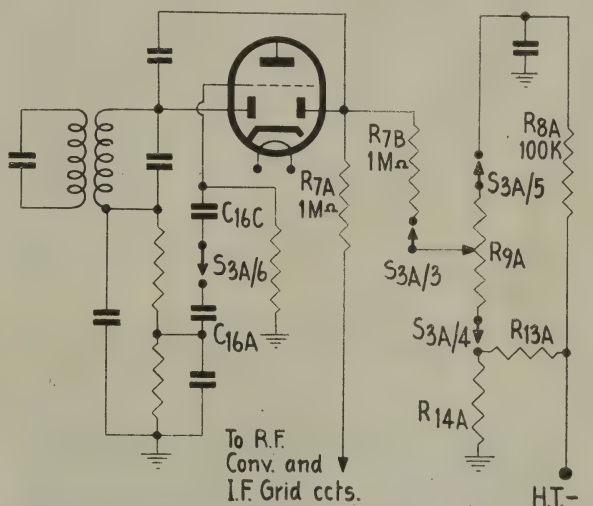
(b) It is also necessary to disconnect or remove the lead from the fuse to the series parallel heater network, otherwise a complete new set of tubes will be required! The fuse and mounting can be retained or removed as desired.

(c) Disconnect or remove the connection from the power-switch side of the fuse which normally passes to the meter via R20A and the meter press-switch S7A. The easiest way to do this is to remove the resistor R20A (200 ohms), which is situated in the immediate rear of the ON-OFF power switch.

(d) There will now appear on the H.T. positive a potential of about 400 volts, which is considerably higher than the voltage for which the set was designed. Obviously anode currents will increase considerably, and the current in the negative B lead will exceed the rating of the biassing resistor R13A. For reasons which will appear later, it is advisable to increase the value of R13A from 1400 ohms to about 2800 ohms, and to use a wattage rating of 4 to 5 watts. (R13A is situated to the rear of R20A [see above]). The associated biassing resistor R14A can remain untouched.

(e) The greatly increased plate voltage constitutes an embarrassment in so far as the receiver section is concerned. Although the receiver will operate satisfactorily and with stability with the 400 volts available (which says something for design stability), the signal-to-noise ratio is impaired by the excessive tube noise. It is advisable, therefore, to locate the H.T. lead feeding all the receiver tubes, and to drop the voltage through an additional resistor which should be bypassed with an 8 mfd. electrolytic condenser. If a resistor of 15,000 ohms is used, the H.T. to the receiver will be cut down to approximately 270 volts, which is more than sufficient.

Note: The H.T. lead which feeds the receiving tubes is difficult to identify and locate. To save a few headaches, it is the centre lug of the 5-lug terminal strip at the back of the chassis. There are two red wires connected to this lug. A careful visual



Circuit of the manual volume control of the ZC1 when the set is switched to C.W.

inspection will indicate which wire to disconnect. The disconnected wire is then connected to the 15,000 ohm resistor, the other end of which is soldered to the centre lug, and this point bypassed by the aforementioned 8 mfd. condenser. It has been assumed that a 12 volt A.C. winding has been connected to the series parallel heater network, i.e., one side to chassis and the other side to the lead previously disconnected from the fuse (see above).

The receiver will now be found to operate very satisfactorily, although on "CW" the "feel" of the volume control will be considerably different from normal. This could be corrected by increasing the value of R8A from 100,000 ohms to approximately 250,000 ohms or more, thereby reducing the grid bias voltage fed to the controlled tubes by the volume control when on CW operation.

THE TRANSMITTER

The conversion to A.C. operation and the increase in the H.T. D.C. voltage is primarily intended for the benefit of the transmitter—the idea being, of course, to increase the power handling capacity. The conversion involves a number of complications, the chief of which is the problem of energising the aerial

change-over break-in-relay. One method would be to rewind the relay bobbin with 40 B & S wire and to insert it between H.T. and earth with a suitable dropping resistor in series—but there is now the disadvantage in that the key is "HOT."

Another method which should enable the relay to operate from the 12 volt A.C. heater circuit would be to slot the pole piece (like the screw driver slot in the head of a screw) with the slot off centre to the extent of half the width of the slot. In other words, one edge of the slot would coincide with the diameter of the pole piece. The slot could be double the width of a hack-saw blade—by inserting two blades in the saw frame—and as deep as it is wide. A heavy copper wire should then be shaped square by beating and the square cross-section wire driven into the slot. The projecting ends should then be bent round the major arc, butt jointed, and carefully soldered.

A further method is to insert two 4½ volt "C" batteries in series with the relay winding. As the relay bobbin has a resistance of 55 ohms, the current flowing will be about .17 amp. which is somewhat heavy for long life of the "C" batteries. If this method is used, it is necessary to remove other current consuming shunts—particularly L9A (below the small remote control keying relay). Also remove resistors R11B (200 ohms) and R11A (200 ohms), otherwise these three additional shunts will seriously shorten the battery life to a matter of a very few hours. R12A can also be removed, thereby removing an additional 10 ma. drain.

One of the simplest methods, however, is to use a full-wave selenium plate rectifier unit across the 12 volt A.C. heater winding. Unfortunately, one side of this winding normally goes to chassis to complete the heater circuit. Consequently, it is necessary to choose one of two alternatives: (a) Remove the chassis returns from the "Key" and "Mic" microphone input transformer (T2A), and connect them to one of the output terminals of the rectifier unit. The other output connection goes to the other side of the relay winding after having cut the lead which normally connects this point to the 12 volt + ve side of the heater circuit. If these alterations are not made, one section of the rectifier unit is short circuited.

Unfortunately, when ZL2BK made all these alterations, he apparently lost track of some of the wires involved in these alterations, with the temporary result that the microphone pressel switch fails to operate the relay. In the meantime, the key is being used as the switch when transmitting on "phone."

(b) The alternative to the above is to leave all the chassis return circuits normal, except the heater network. By removing all chassis connections from this network and rewiring the open ends back to the 12 volt A.C. winding, the whole heater network can be isolated from chassis and the same result is achieved.

Both these methods have been tried with similar results. In each case a certain amount of low level hum is introduced into the microphone circuit, but it is not objectionable, and no doubt simple and effective means will be found to obviate this small defect.

The second method requires patience and care as access to the appropriate valve sockets is poor in several cases. Care should also be taken to ensure that in the case of valves V1E and V3A, the cathode connections to chassis are restored separately because the cutting of the chassis connections to these valves also cuts the cathode circuit.

MODULATION

Even with the normal ZC1 the percentage of modulation is rather low. It is lower still after conversion, and it becomes necessary to do something about it. The easiest way is to replace the 6U7 pre-amplifier (V1G) with a 6J7, at the same time increasing the value of the plate resistor R8D from 100,000 ohms to 250,000 ohms and the screen resistor R4D of .5 megohms to at least 1 megohm. A considerable improvement to tonal quality is obtained if the cathode bypass condenser C6D (.1 mfd.) is replaced by an 8 mfd. electrolytic condenser to restore the bass reproduction, which was deliberately attenuated in the normal ZC1.

The modulator tube V4B (6V6GT) can be directly replaced by a 6L6G. If it is desired to retain the 6V6GT "class C" R.F. amplifier, it will be necessary to shunt the heater connections of the latter tube with about 13 ohms to balance this section of the heater network. Alternatively, the "class C" R.F. amplifier can also be replaced with a 6L6, in which case no shunt is necessary. **Note** that a 6L6, not a 6L6G, must be used as the R.F. tube in order to obtain effective shielding to avoid instability and parasitic oscillations.

"CHIRPS" ON C.W.

On C.W. operation there is a distinct tendency for the oscillator to "chirp" due to the violent change in plate voltage during keying. This tendency can be reduced to negligible proportions—without apparently affecting the drive to the buffer—by connecting an additional resistor of about 100 000 ohms from plate to chassis, thereby providing a stabilising bleeder. Possibly stabilising the screen voltage would be more effective still.

AERIAL ARRANGEMENTS

The effective power handling capacity of the converted ZC1 depends entirely on the aerial system employed and the extent to which it will load the final amplifier. It was found that an 80 metre half-wave end-fed aerial is very effective if a condenser is connected between the aerial and earth terminals and the minimum amount of inductance used in the aerial loading coil. For the condenser a 385 mmfd. variable is used, which when full in, and with the aerial loading coil controls set at Coarse 1 Fine 3, produces good loading as indicated by the milliammeter. Unloaded, the tube current reads about 26 ma. —loaded 100 ma.—i.e., 40 watts.

For 40 metres the loading coil controls should all be set at position 1 and the condenser swung to about half capacity position when the ma. meter will read about 70 ma.—the aerial then acting as an end-fed full wave type.

From the above, the indications are that if the aerial loading coil is dispensed with altogether and the series links on the final tank coils L12A, L13A, taken direct to the appropriate aerial relay contact, the results would be even better—although for 80 metres it would be necessary to use a condenser of about 400 mmfd. maximum between aerial and earth.

OTHER POSSIBILITIES

There are probably many other possible amendments which could be incorporated to still further improve the ZC1, but the above should be sufficient to go on with! For instance, although the receiver is already a good one, it would be possible to bandspread the 80 and 40 metre bands very simply by inserting accurately matched mica or silver mica condensers in series with each gang section. The fact that both the 80 metre and 40 metre bands are substantially at the high frequency ends of each tuning range facilitates this change without complications. Perhaps EF39 valves could replace the 6U7's in the R.F. and I.F. stages, and an ECH35 in place of the 6K8GT. Similarly, in the transmitter, the pre-amplifier could with advantage be replaced with an EF37, and the modulator itself with a steep slope power penthode of the EL37 type.

RESULTS OBTAINED

Apart from all this, however, the low investment involved in the purchase of ZC1 is quite out of the ordinary in these days of high prices. It is an excellent piece of equipment with communication possibilities which are remarkable. For instance, ZL2BK in five weeks has worked on 'phone and CW about 70 N.Z. stations throughout New Zealand, with VK stations on both CW and 'phone, and with half a dozen W's on CW on 40 metres.

The fact that the transmitter can be netted to any frequency with such speed and ease, is a valuable asset, which not only speeds up communication, but also reduces the number of channels in use at any one time, and permits the operator to quickly slip into a temporarily vacant channel with consequent reduction in QRM. Above all, it permits the operator to know his frequency of transmission reasonably accurately, and there is no excuse whatever for transmitting outside the band limits.

No doubt, theoretical considerations of the above conversion will indicate still further improvement—particularly in regard to modulation loading, etc., but these notes will have served their purpose admirably if they produce further comment from those interested. Any other solutions or amendments will be welcomed.

Note: Circuit inaccuracies in ZC1 diagram: Coupling condenser pre-amp. to modulator is shown as C18I. It should be C16I. Similarly, V3A grid coupling condenser to switch S3A/6 should read "C16C" instead of "C16A."

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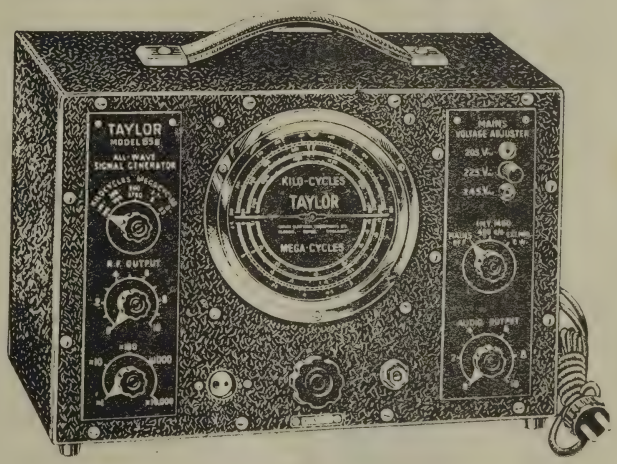

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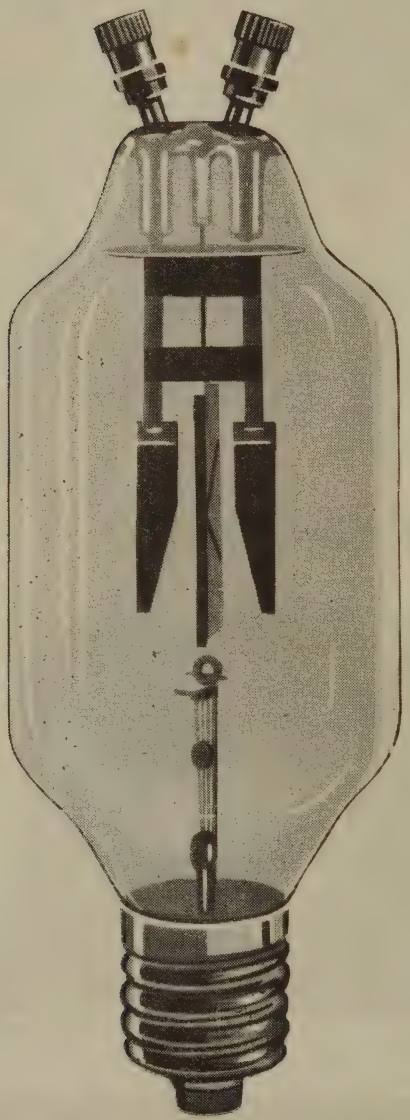

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451	1.3	2 x 16
367	6	2 x 45
1010	1.3	2 x 60
1037	6	2 x 60
1039	15	2 x 60
1049	25	2 x 60
1054	40	2 x 48
1059	40	2 x 60
1063a	6	3 x 250
1069	60	2 x 55
1089	10	2 x 60
1533	15	3 x 250
1534	15	2 x 275
1554	40	2 x 275
1710	3	2 x 130
1725	1.3	2 x 130
1729	6	2 x 95
1738	15	2 x 95
1749	25	2 x 95
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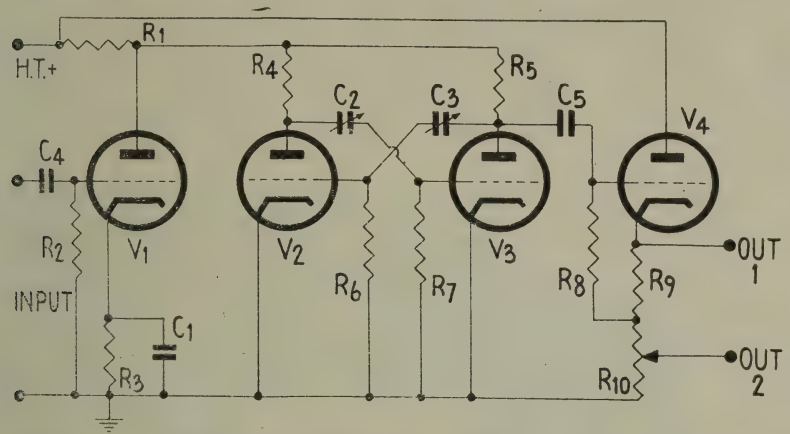
MEASUREMENT OF FREQUENCY

Part VI

ADJUSTING THE 100 kc/sec. MULTIVIBRATOR

The first necessity in adjusting this part of the circuit is to set up the multivibrator coupling condensers so that, **without** locking voltage being injected, the circuit oscillates at slightly less than 100 kc/sec.



V_1, V_4 = 6J5 or ½ 6SN7.
$V_2 + V_3$ = 6SN7.
R_1, R_3 = 2k.
R_4, R_5 = 25k.
R_6, R_7 = 100k.
R_2 = 500k.
R_8 = 1 meg.
R_9 = 500 ω
R_{10} = 50k. pot.
C_1 = 0.01 μf.
C_2, C_3 = 3-30 $\mu\mu f$. air trimmer.
C_4, C_5 = 100 $\mu\mu f$. mica.

Circuit and values for the 100 kc/sec. portion of the frequency standard. Details of connections to the previously described 1000 kc/sec. section are found in Part IV of this series.

It is here that the absolute necessity for a regulated power supply becomes apparent, for the multivibrator is very sensitive to changes in H.T. voltage. First of all, the 1000 kc/sec. oscillator is set to exactly its correct frequency by means of a receiver, and WWV. The receiver is now turned to a wave range which gives a suitable spread between 1 mc/sec. dial divisions. The next highest wave range to the broadcast band is suggested, and the low-frequency end of this range. For example, if the receiver has a range from, say, 2.5 mc/sec. upwards, we will want to use that part of the dial between 3 and 4 mc/sec.

First of all, the 3 and 4 mc/sec. points on the dial are calibrated by means of the 1000 kc/sec. standard. Next, the 6N7 1000 kc/sec. oscillator tube is removed, and the 6SN7 multivibrator tube is placed in its socket. The trimming condensers C_2 and C_3 are set at approximately half way, and our attention is turned to the receiver. The output terminal of the standard is coupled loosely to the aerial lead of the receiver, so that turning the dial ought to bring in a series of signals, which are direct harmonics of the multivibrator. Now, tune the receiver to the 3 mc/sec. mark, previously calibrated by the standard. If one of the multivibrator harmonics comes in right "on the nose" at this setting, the next step may be proceeded with. If not, the multivibrator condensers should be adjusted (simultaneously) until this takes place. Now, if the multivibrator is running at exactly 100 kc/sec., it will be possible, on tuning the receiver towards 4 mc/sec., to count **nine** signals between the 3 and 4 mc/sec. marks. The tenth should lie exactly on the 4 mc/sec. mark.

It is unlikely that this happy state of affairs will be struck at the first try, but it should be possible from the first count to tell whether the multivibrator is running at too high or too low a frequency. In adjusting the condensers, it should be remembered that their capacity range is such as to allow the circuit to oscillate over quite a wide frequency range. Thus, if the frequency is fairly close to the right value at first, only a very small shift should be made before counting the signals again.

Now, all that remains to be done is to adjust the condensers until the multivibrator is running slightly slow. That is to say, the correct adjustment is where not quite nine signals are found between the 3 and 4 mc/sec. calibration marks. The easiest way of making the adjustment is to find the setting which gives as nearly as possible the correct frequency of 100 kc/sec., and then increase very slightly the capacity of the two condensers.

Next, the 1000 kc/sec. oscillator tube is replaced, and the input control to V_1, the locking tube, is advanced slightly from zero. While doing

this, listen to one of the multivibrator harmonics in the receiver, and note carefully the point at which the signal suddenly snaps off tune. This means that the locking voltage has taken control. The problem now is to decide whether the locked frequency is the correct one of 100 kc/sec., or not. For instance, if locking is taking place at the 8th harmonic of the multivibrator, it will be running at 125 kc/sec., or if it is locking at the 9th harmonic, it runs at 83.3 kc/sec. Which of these states exists can easily be checked by again counting the signals received between 3 and 4 mc/sec. If the M.V. is running at 83.3 kc/sec., there will be a signal at 3 mc/sec., another at 3.0833 mc/sec., another at 3.1666 mc/sec., another at 3.25 mc/sec., and so on. This will cause there to be **eleven** signals between 3 mc/sec. and 4 mc/sec. On the other hand, if the M.V. runs at 125 kc/sec., there will be signals at 3 mc/sec., 3.125 mc/sec., 3.25 mc/sec., etc., giving **seven** signals between 3 and 4 mc/sec.

It is important to note that in each case, if the M.V. is locked, but at a wrong frequency, there will always be a signal coinciding with each of the points 3 mc/sec. and 4 mc/sec.

If another source of R.F., such as a calibrated oscillator or signal generator, is available, it is possible, and even desirable, to check the multivibrator frequency in another way. As pointed out above, if the multivibrator is successfully locked, it will be running either at 83.3 kc/sec., 100 kc/sec., 125 kc/sec., or some other frequency even more remote from the desired frequency. Thus, with a calibrated signal source which is only approximately accurate, and with a simple detector circuit, untuned or otherwise, it is possible to check which frequency the multivibrator is on. Of course, the above figures refer only to the case where the 1000 kc/sec. oscillator is on frequency itself, but the method of setting this has been explained, and there should be no difficulty in setting it with considerable accuracy. Once the 1000 kc/sec. oscillator has been set, it should be correct within a few cycles a second very shortly after it is switched on, even if the setting was performed some time ago. Nevertheless, it is a very good plan to allow it to warm up for at least half an hour before attempting to set the frequency of the multivibrator.

CHECKING WITH A SIGNAL GENERATOR

The method of checking the locked multivibrator frequency against the calibrated oscillator or signal generator is as follows:—

First, a simple diode detector circuit is connected up, including a pair of headphones. Then, this is coupled to V_4, the 100 kc/sec. buffer, via a mica condenser and the moving arm of R_{10}, called "Out 2" on the diagram. The potentiometer R_{10} is now advanced a little from the earthed end, so as to feed a small fraction of the multivibrator output to the detector. Next, the signal generator is coupled loosely to the detector circuit by wrapping a few turns of insulated wire round the lead to the diode plate and connecting this wire to the signal generator output terminal.

The signal generator is now tuned to 100 kc/sec., and, if the multivibrator is on frequency, an audio beat note should be audible in the headphones. As long as the beat is heard with the signal generator tuned to somewhere near the 100 kc/sec. mark, and not near the 83.3 kc/sec. or 125 kc/sec., it can be assumed that the multivibrator frequency is correct. It should be quite easy to spot by this method the frequency to which the multivibrator is locked. If no beat note can be heard at all, the chances are that the multivibrator output is either too great or too small, and the effect should be tried of varying slightly the position of the moving arm R_{10}, then retuning the signal generator to listen for beats once more.

A WORD OF WARNING

The above adjustment procedure, though quite simple to describe, is not very easy to carry out, and requires much patience and care, but once proper adjustment has been obtained no trouble should be experienced.

There is one point in the adjustment of the multivibrator that calls for some special explanation, and that is the question of adjusting the locking voltage by means of the cathode potentiometer of the 1000 kc/sec. cathode follower.

As has been mentioned above, it is possible to obtain locking, but on the wrong frequency. Now, as the amplitude of the locking voltage is varied, the M.V. will jump suddenly from one of the possible locking frequencies to another. There is a *range* of locking voltage amplitude over which locking at 100 kc/sec. will be obtained. If the locking voltage is now increased, the multi-

vibrator will suddenly jump to 93.3 kc/sec., or, if it is decreased, it will either become unlocked altogether or will jump to 125 kc/sec. Its behaviour, in fact, is very similar to that observed in synchronising the time-base of an oscilloscope. **For this reason, it is not sufficient simply to find a locking amplitude which locks the M.V. on 100 kc/sec. The adjustment that must be found is the centre of the range over which locking at this frequency occurs.**

A difficulty which may be encountered here is that if the free-running frequency of the M.V. is not very suitable, the range of the 1000 kc/sec input control over which 100 kc/sec. locking occurs may be very small. If this is found to be the case, an improvement may be effected by means of a *very slight* adjustment to C_2 and C_3, the coupling condensers of the M.V. When this has been made, the locking voltage should be varied again to find where correct locking occurs.

The proper procedure is to find the points on the locking voltage control at which the M.V. flips from 100 kc/sec to the two nearest locking frequencies (83.3 and 125 kc/sec.) and finally to set the control midway between these points.

If this method is carried out, there will be very little chance of slight disturbances in circuit voltage, etc., causing the M.V. to flip to one of the wrong frequencies, unknown to the operator of the gear.

(To be continued.)

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THE DESIGN OF REACTANCE TUBE CIRCUITS

In this article reference is made to the circuit of Fig. 1, in which V_2 is an oscillator, controlled by the reactance of tube V_1. The problem confronting a designer who wishes to use this circuit is that of choosing the constants Lo, Co of the oscillator tuned circuit, R and C of the phase-splitting network, and the tube V_1 in such a way that a given frequency deviation is secured either for A.F.C. purposes or for frequency modulation of the oscillator V_2.

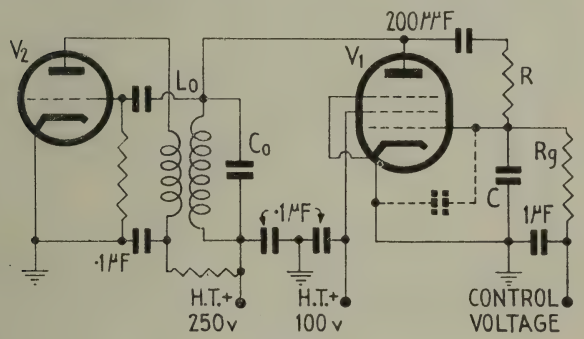

FIG.1

The reactance tube circuit referred to in the text. V_2 is the controlled oscillator, and V_1 the reactance tube. Rg should be the maximum permissible grid resistance for the tube. The method of choosing R and C, the phase-splitting network, is described in the text.

It has been shown elsewhere [1], [4] that the circuit of V_1 in the diagram acts as an inductance shunted across Lo Co, the oscillator tuned circuit, and that the apparent inductance of V_1 is dependent on its mutual conductance, gm.

From an inspection of the circuit, it is evident that the smaller Lo, the greater the frequency deviation. This follows simply from the fact that if Lo is small, the effective inductance of the reactance tube has a greater effect on the total inductance than when Lo is large. Thus, it is apparent that, within limits, the attainable frequency deviation is controlled (for a given oscillator centre frequency) by the L/C ratio of the oscillator tuned circuit.

It is almost self-evident, too, that the frequency deviation depends upon the range of gm covered in the control tube when its grid is swung from cut off (when the effective inductance is infinitely great) to normal minimum bias, at which point the so-called electronic inductance is smallest, and therefore has its greatest effect on the frequency of the oscillator.

It is not self-evident, however, that the constants of the phase-splitting network R, C, affect the frequency deviation, but this is found to be the case.

A recent analysis of the problem by Ross and Sandel [4] indicates that, although it is quite possible in a particular case to calculate the effective inductance of the control tube V_1, this is not very useful as an answer to the design problem. A more directly usable approach is to combine in one formula all the relevant factors, giving the frequency of the oscillator in terms of the frequency when the control tube is at cut off. This is because, with the control tube cut off, the oscillator frequency is that determined by Lo and Co alone, in the ordinary manner. Thus Ross and Sandel give the result of their calculations in the form—

$$F^2 = F_0^2 \left[\frac{Logm}{C\ R} + 1 \right] \quad \text{..... (1)}$$

where Fo is the frequency of oscillation, with V_1 at cut off,

F is the frequency of oscillation when the mutual conductance of the control tube is gm.

Lo is the inductance of the oscillator coil, and C and R are the values of the phase-splitting network.

NOTE.—all units are in c/sec., mhos., ohms, and farads.

An examination of equation (1) shows that:

(1) As gm increases, so does the oscillator frequency.

(2) When gm = 0, $F^2 = Fo^2$. This corresponds to the condition where V_1 is cut off.

(3) The frequency decreases as the product CR increases. Thus, for a given value of Lo and gm, the frequency deviation is smaller the greater the CR product, and vice versa.

Equation (1) can therefore be used to find the maximum frequency if the following are known. The resonant frequency of the oscillator circuit with V_1 non-existent, the values of Lo, C

and R, and finally the mutual conductance of V_1 at its normal minimum bias, usually 3 volts. However, being able to do this does not help very much in fixing the value of CR product if this is unknown and has to be designed. But, if all the other quantities are known, equation (1) will enable CR to be found. The choice of values for C and R is not indicated by equation (1), and depends partly upon whether linear control is desired over the whole range. This point will be dealt with later.

Fig. 2 is a graph of mutual conductance against grid volts for the tube 6U7G. It will be noted that the curve is linear from − 3 to − 8 volts, but that, at higher voltages, the mutual conductance tails off in a very pronounced manner. The range of mutual conductance covered by the linear portion of the curve is from 1600 micro-mhos to 430 micro-mhos. Thus, if linear control is desired with this tube, the standing grid bias should be 5½ volts, and the peak grid voltage should not exceed 2½ volts. Consideration of this curve brings to light a limitation in the usefulness of equation (1). In the latter, Fo is the frequency of the oscillator when gm equals 0, but Fig. 2 shows that gm must not fall below 430 micro-mhos if control is to remain linear; consequently, Fo is never reached in practice. Nevertheless, for approximate purposes, such as during initial design, where great accuracy is not required, Fo can be regarded as the minimum frequency and equation (1) used. Ross and Sandel (loc. cit.) realised this difficulty and overcame it by developing a further equation from which Fo has been removed and replaced by F_1, corresponding to the lowest frequency actually obtained, and therefore in the case of the 6U7 to a bias of − 8volts.

This new equation is—

$$CR = \frac{Lo\,F_1}{2\,\beta.\,S} \quad \text{..... (2)}$$

where F_1 is the lowest frequency corresponding to the point of highest negative bias,

S is the frequency sensitivity in cycles per mho, and

β equals F_2/F_1 where F_2 is the highest frequency, corresponding to the point of the lowest negative bias.

Thus the frequency deviation is $F_2 - F_1$, and the centre frequency is $(F_2 + F_1)/2$.

Equation (2) may be used to complete the design of the reactance tube circuit in the following manner:—

(1) A suitable value for Lo is chosen. This may already be fixed by other considerations. For instance, if the control tube is to work on the oscillator of a broadcast receiver, Lo is already known, since it is determined by the design of the receiver, without regard to the addition of automatic frequency control.

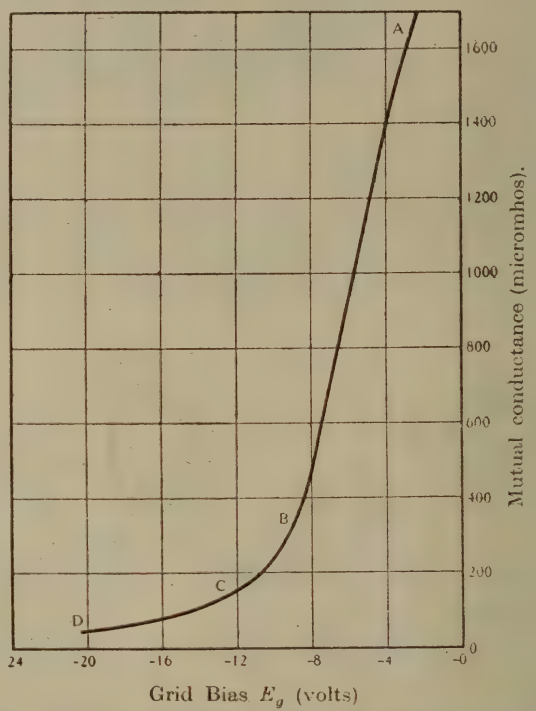

Fig. 2. Curve of mutual conductance against negative grid voltage for the 6U7-G. The curves for other remote cut-off pentodes are not greatly different from this one.

(2) The total frequency swing is decided upon. Taking again the example of A.F.C. for a broadcast set, linear control may be required to an extent of plus or minus 5 kc/s. about the centre frequency. For design purposes, it is reasonable to work at the middle of the broadcast band, say 1000 kc/s., so that in equation (2), assuming an I.F. of 455 kc/s., the oscillator frequency would be 1455 kc/s. We therefore have F_2 = 1460 kc/s., F_1 = 1450 kc/s., and $(F_1 - F_2)$ = 10 kc/s. Also, β = 1460/1450 = 0.925, which can be substituted in equation (2).

(3) The sensitivity S is calculated from $(F_2 - F_1)/(gm_2 - gm_1)$, where gm_2 is the mutual conductance at minimum bias, and gm_1 that at maximum bias. In the case of the 6U7, gm_2 = 1600, and gm_1 = 430 micromhos, so that $(gm_2 - gm_1) = (1600 - 430)/10^6$ mhos. So that

$$S = \frac{10{,}000 \times 10^6}{1170} = 8.55 \times 10^6 \text{ cycles/mho.}$$

This value can be inserted in equation (2).

(4) The arithmetic is now worked out and results in a value for CR.

The only step remaining to complete the design is to fix a value either for C or R. This enables the other to be found from the CR value already worked out.

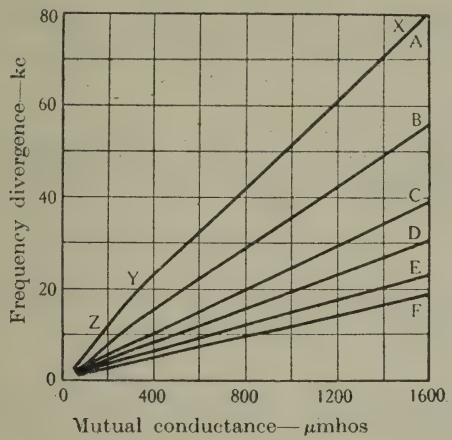

Fig. 3. Showing the actual frequency divergence obtained with the circuit of Fig. 1 and the accompanying values. Lo = 61 mfd. H, C = 68 mmfd, fo = 1300 kc/sec. R has the following values for the respective curves, which show how the frequency swing and linearity vary with the value of R:

A = 10,200 ohms	**D = 29,700 ohms**
B = 15,200 ohms	**E = 40,400 ohms**
C = 22,300 ohms	**F = 51,000 ohms**

CHOICE OF CR VALUES.

Since the design procedure outlined above gives us a value of CR and does not specify any particular value of either, the point arises as to what difference is made by choosing either a low value of C in combination with a high value of R, or the opposite. This is governed by practical considerations. Obviously, too high a value of R cannot be chosen, since by so doing an impossibly small value of C might be arrived at. In practice, C cannot be reduced below the grid-cathode capacity of the valve, plus stray capacities introduced by wiring. Secondly, too small a value of R results in a non-linear characteristic of frequency against control voltage. Fig. 3 is a reproduction of experimental results obtained by Ross and Sandel using the circuit of Fig. 1 and the values shown in the caption. C was fixed at 68$\mu\mu f$. while R varied in the steps shown between 10,200 and 51,000 ohms. It will be noticed that as R decreases, the frequency deviation increases, but that the linearity becomes worse at the same time.

The procedure given above will enable suitable constants to be worked out for a 6U7 valve, since we have given for it the curve of mutual conductance against grid volts. In order to use the equations to apply to any other tube, this curve must be drawn experimentally for the tube in question if accurate results are desired. If, on the other hand, approximate results only are required, a sufficiently good answer may be obtained by putting gm_2 equal to the rated mutual conductance at a bias of -3 volts, and gm_1 equal to zero. In addition, the standing bias can be made approximately 5 volts for any of the usual variable-mu tubes such as the 6K7, 6SK7, 6D6, etc., whose characteristics are not very different from those of the 6U7G.

Extreme attention need not be paid to linearity of control if the reactance tube is to control an oscillator only for A.F.C. purposes, but the point should receive careful consideration in the design of reactance tube modulators for frequency modulated oscillators in FM transmitters or in FM alignment oscillators.

References:

[1] Foster and Seeley, Proc. I.R.E., 1937, Vol. 25, page 289.
[2] M. G. Crosby, R.C.A. Rev., 1940, Vol. 5, page 89.
[3] E. S. Winlund, Proc. I.R.E., 1941, Vol. 29, page 390.
[4] Ross and Sandel, A.W.A. Tech. Rev., 1943, Vol. 6, No. 2.

CANTERBURY PROJECT

Interest by Australian scientists in the Canterbury project is being evidenced by the arrival in New Zealand of three members of the Radio Physics Laboratory, which is a branch of the Australian Council of Scientific and Industrial Research.

The party is headed by Mr. Pawsey, acting-chief of the Radio Physics Laboratory, and Messrs. Pearcy and Squires comprise the remaining members.

As similar work is being undertaken in Australia, exchanges of knowledge should be mutually beneficial.

We understand, however, that the Canterbury weather does not take kindly to scientific investigation, as it is reported that since the expedition became operational there have been fewer nor-westers for the time of the year than for many years.

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If the tube has defective electrodes, its transconductance will be affected. The effectiveness of the tube to function as a grid-controlled amplifier is revealed by the correlation of plate current and grid voltage increments by this test.

The dynamic transconductance test has the advantage that it is rapid, gives direct indications, and more closely approximates actual operating conditions than does the static transconductance test.

TESTING CLASS-B TUBES

Class-B amplifier tubes, such as types 6A6, 6N7, 53, etc., are checked for power output, since it is not convenient to check these types for transconductance. The circuit shown in Fig. 4 is satisfactory.

A 50-cycle signal voltage is applied to the control grid of the tube under test by means of transformer T. Taps on the secondary winding of this transformer enable the operator to obtain the recommended driving voltage for each tube type. The series grid resistor, Rg, simulates the reflected impedance of the driver stage found in class-B amplifiers. When a dual tube is being tested, electrodes of the "floating" section are connected to the cathode of the section under test, as shown in Fig. 4.

A.C. output voltage (E_O) is developed across the load resistor, R_L, which is selected to have the proper ohmic value for the tube under test. This voltage, which is proportional to power output, actuates a voltmeter consisting of the A.C. milliammeter, variable multiplier (Rm), and 1-mfd. coupling capacitor (C).

Class-B tubes are rejected when their power output (E_O^2/R_L) falls to about 55 per cent. of its rated value. When the tube under test is operated at its recommended grid driving voltage and rated load resistance, the English scale of the tester may be standardised for a specific class-B tube in the following manner: Rheostat Rm is set to bring that deflection of the meter corresponding to 55 per cent. of rated power output to the top of the BAD or REPLACE section of the scale.

TESTING RECTIFIER AND DIODE TUBES

Diode and rectifier tubes and the diode sections of multi-section tubes are checked in a manner similar to the emission test described earlier in this article. The tube filament or heater is operated at rated value, and a 50-cycle voltage is applied to the series circuit embracing the diode (or rectifier section), a D.C. milliammeter of appropriate range, and a load resistor. A satisfactory circuit is shown in Fig. 5. The load resistor is shunted by a capacitor. Each type of tube is rejected when its rectified current, as indicated by the milliammeter, falls to 80 per cent. of the rated value for the RMS voltage applied. Current and voltage data for this test are obtained from the graphs and tables supplied by tube manufacturers.

A meter shunt rheostat (Rm) is set to bring the meter deflection corresponding to 80 per cent. of rated current for a specific type of tube to the top of the BAD or REPLACE section of the English scale.

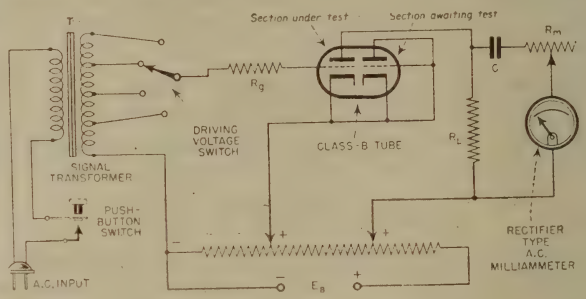

Fig. 4. Circuit for power output test for Class B tubes. These are not satisfactorily tested by the transconductance tests.

TESTS FOR SHORT CIRCUITS

Several schemes have been devised for locating interelectrode short circuits in a tube. One of the simpler circuits, often incorporated in complete tube testers, is shown in Fig. 6. In this arrangement, a 115-volt potential is applied in series with a ½-watt neon lamp between any one electrode of the tube and all of the others in parallel. As the switch is rotated, different parallel combinations of electrodes are checked against other single electrodes. The tube is operated at its rated filament or heater voltage. A continuous glow of the neon lamp indicates a short circuit.

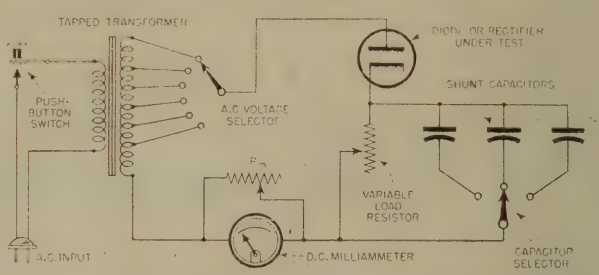

Fig. 5. Circuit for testing diode types, either rectifiers or diode detector tubes.

The electrode combination to be checked for short circuit is selected by means of a rotary switch, S_1. The points of this switch have been numbered in Fig. 6 to correspond to numbering of the tube socket terminals. Thus, when pole A of switch S_1 is in position 2, as shown, the short-circuit test is made between socket terminal 2 and the parallel connection of terminals 1, 2, 3, 4, 5, 6, 7, 8, and 9. Terminal 9 is the top-cap grid connection.

If the lamp should glow with switch S_1 in the position shown, a short-circuit would be indicated between either 1 & 2, 2 & 3, 2 & 4, 2 & 5, 2 & 6, 2 & 7, 2 & 8, or 2 & 9. In order to locate exactly the second electrode contributing to the short circuit, the switch is rotated, noting that the lamp glows for

When making a complete short-circuit test, the operator must be familiar with the tube base connections in order best to interpret the flashlamp indications. Some tubes, for example, have two base connections to a single electrode. An example is the 45Z3 whose plate is connected to pins 2 and 6.

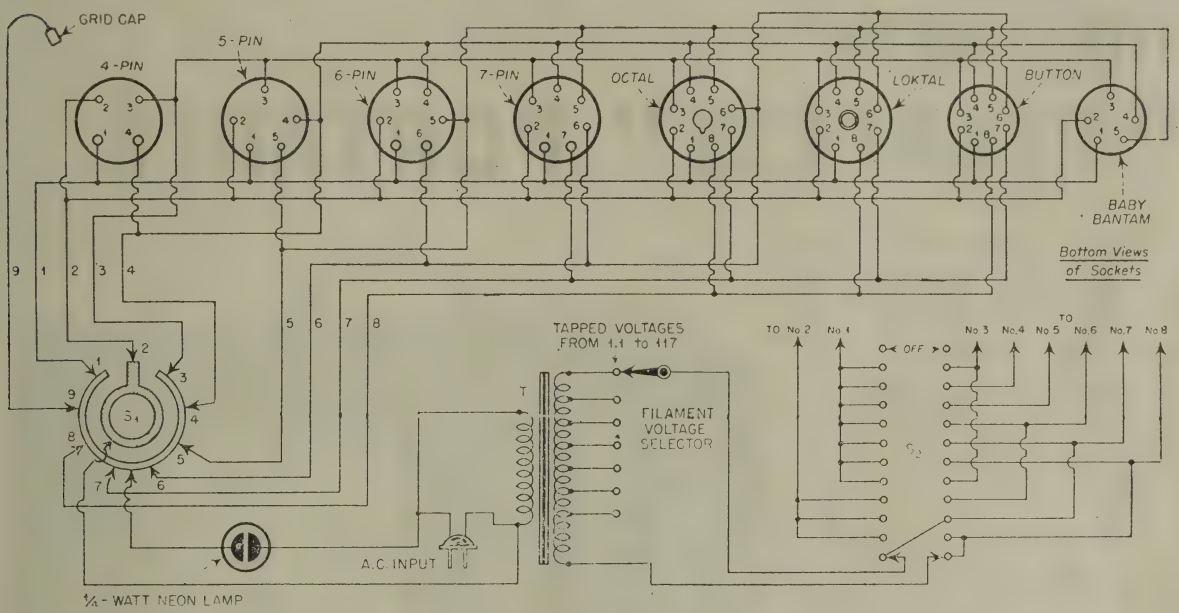

Fig. 6. Complete circuit for testing any valve types for short-circuits between any two elements.

a second time when the pole is set to the second electrode. Thus, a 2-9 short circuit will be indicated by glowing of the lamp when S_1 is at settings 2 and 9. If more than one interelectrode short circuit is present at any switch setting, the individual ones may be located, as just explained, by successive settings.

Sockets are included to accommodate all tube bases. Filament voltage is supplied by the tapped transformer, T, to all tubes, and is applied to the proper socket terminals by means of the 11-position switch, S_2. Socket filament terminal combinations selected by this switch are 1-3, 1-4, 1-5, 1-6, 1-7, 1-8, 2-3, 2-6, 2-7, 2-8, and 7-8.

In order to prevent switch S_1 from short circuiting and extinguishing the tube heater during operation, an auxiliary set of contacts is provided on S_2 which opens one leg of the leads between S_1 and the filament or heater terminals of the sockets. One leg of the heater line is still left accessible to S_1 for short circuit test against all other electrodes. These auxiliary contacts have been omitted from the schematic in Fig. 6, in order to minimise confusion in reading the drawing. The lines opened by the contacts are No. 1 when S_2 is in one of the seven topmost positions, No. 2 when S_2 is in the next three positions, and No. 8 when S_2 is in the lowermost position. By setting S_2 to its OFF position, heater voltage is removed from the tube and the short-circuit test may be applied (for continuity indication) between the heater terminals.

Such base connections will yield a continuity test which might be taken erroneously as a short circuit between terminals 2 and 6. From standard tube data, it will be easy to identify all terminals (such as filament or heater connections, and cases such as the one just cited) between which continuity should be expected, and to determine corresponding switch positions.

COMPLETE TUBE TESTS

This article has dealt with the principles underlying service tube testers. The separate test circuits shown may be combined into a single complete, field-type instrument, such as carried by radio servicemen, by means of ingenious switching systems. And this instrument may be used for complete tube tests including transconductance or emission of regular triodes, tetrodes, pentodes, and converters; power output of class-B tubes; rectified current of diodes and rectifiers; and short circuits in all types.

The next article will describe the complete circuits employed in field tube testers.

'RADIO and ELECTRONICS'

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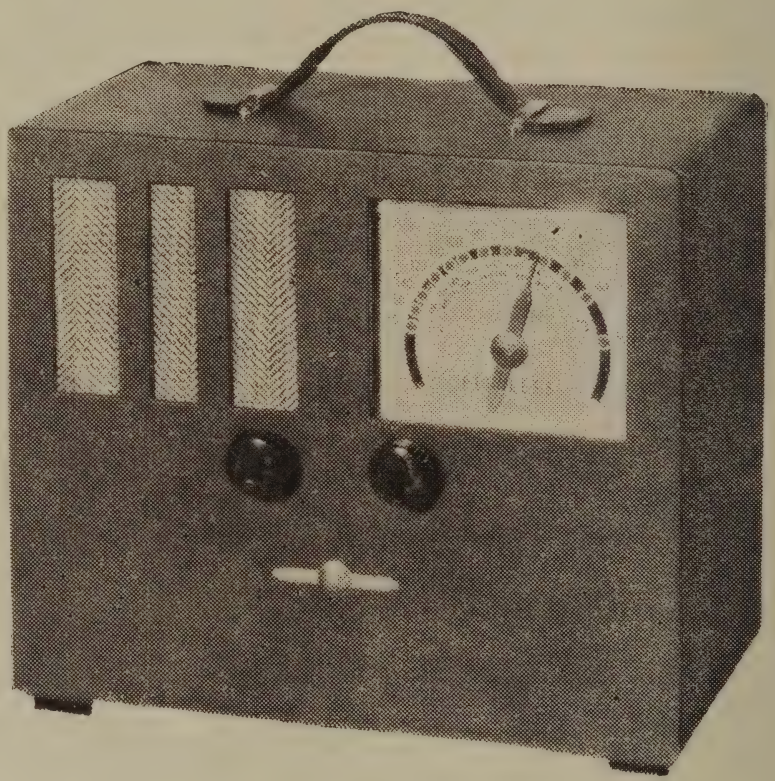

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TRADE WINDS

ADVERTISERS' ASSOCIATION ELECTS NEW PRESIDENT

At the election of officers at the fifteenth annual general meeting of the Association of New Zealand Advertisers, the resignation of Mr. E. L. Rutledge necessitated the selection of a new President. When speaking, Mr. Rutledge, Managing-Director of 20th Century Fox Films Corporation, announced that he was retiring, on medical advice, from a position he had occupied for twelve years. He expressed his appreciation of the happy relations he had always enjoyed with the Council and stated that he would continue to be interested in their affairs.

On the motion of Messrs. R. A. Lock and H. G. Miller, Mr. C. H. Roser, a vice-president and an original member of the Association, was elected President. Mr. Roser is very well known in the radio and electrical field, and for the last 26 years has been with the National Electrical and Engineering Company, Ltd., where he occupies the position of Radio and Advertising Manager.

The election of officers resulted as follows:—Vice-Presidents, Messrs. R. A. Lock and W. J. A. Chartres; Council, Messrs. Malcolm Adams, R. C. Field, K. W. Fraser, G. Waite, S. S. Scott, and H. W. Miller; Hon. Treasurer, Mr. G. McKnight; Auditor, Mr. T. L. Buxton.

NATIONAL CARBON CO., LTD., INSTALL NEW PLANT

The National Carbon Company's Eveready factory at Rosbury, New South Wales, has been enlarged to accommodate new plant for the production of Minimax batteries.

The production of these batteries, which were on the point of release just prior to the outbreak of war, proceeded apace throughout the war years. To-day, having the same capacity as a pre-war battery of twice the size, Mini-max batteries are the answer to portable power supplies.

Mr. R. D. Greenwood, Managing-Director of National Carbon Co., Ltd., in New Zealand, has been engaged recently in discussions with radio manufacturers relating to "portable" manufacture. Apparently most members of the industry have their new models well under way, and some are already available to the public.

ACHIEVING PERFECT RADIO RECEPTION

A review of Britain's post-war radio sets by G. A. T. BURDETT, Electrical Engineer.

Extraordinarily good progress has been made in Britain, since World War II ended, in the design and manufacture of radio receivers. Well over 100 family table models have appeared as well as a number of console receivers, radio gramophones, electric record reproducers, all-dry portable sets and car radios.

Components are largely standardised, but their arrangement and connection on the chassis vary between makes. Superheterodyne (superhet) principle is universally employed and no straight, or T.R.F. receivers, are mass produced. Most table receivers have four valves, plus a mains rectifier. Radio gramophones and a few larger receivers employ up to eight. Valve sequence varies slightly between sets, but a common coupling for a five-valve receiver for use on alternating current mains comprises: first valve, triode hexode frequency changer; second, intermediate amplifier; third, double-diode-triode combined demodulator, automatic gain control (A.V.C.) and first audio frequency amplifier; fourth, beam tetrode amplifier; and the fifth, a full wave rectifier.

Receivers for the home market in Britain cover long, medium and short wave bands, 1,000-2,000 metres (300 kc/s-150 kc/s); 200-500 metres (1,500 kc/s-545 kc/s); and 16-50 metres (19 mc/s-6 mc/s), which allow listeners in Britain to receive most British and Continental stations. For the export market the long wave band is replaced by a further short wave band.

Tuning Devices

Tuning is more accurate and simple. Most outstanding developments are: flywheel tuning and two-speed methods. The former comprises a fluid flywheel fitted on the tuning spindle, inside the cabinet. Quick traverse between stations is achieved by spinning the knob then, final selection, particularly on short waves, is made by slight finger touch.

Two speed tuning is automatic. Slower vernier movement (ratio 1 in 75) for final selection of station, as well as short wave tuning, is achieved by ordinary rotation of the tuning knob, but for quick traverse over the tuning scale, the knob is turned sharply to engage the higher gear (ratio 1 in 15).

Brightly coloured scales, a different colour for each wave band, edge-lit dials, dials which are illuminated white in daylight and green at night are further tuning developments incorporated in the receivers now produced in Britain.

Band spread tuning, for the short wave-band, where stations are easily missed, has reached the higher stages of perfection. One manufacturer in Britain has introduced a special optical projected system of band spread tuning which also can be carried out at any point on the short wave range.

Push-button tuning has reappeared on the more expensive receivers, where pre-selected programmes can be received by the press of a button. Pre-selected stations may be altered at will, and manual tuning is provided as an alternative.

Tone improvement is marked. Wide research conducted in Britain during the war has resulted in the production of almost-perfect speaker units. Trends are towards larger units of 203 mms. and 254 mms. with their higher quality output and freedom from distortion, instead of 127 mms. and 152 mms. On the other hand, so efficient are the midget speaker units, in the order of 50 mms., used in small radios in tanks and aircraft, that the midget receivers give a quality of tone, combined with signal strength, almost equal to the domestic receiver.

Tone control improvement is also achieved, in receivers produced in Britain, by careful matching of speaker with cabinet, so that cabinet resonance and boom is reduced to a minimum.

Set Without a Cabinet

The most revolutionary design is that of a set without a cabinet. A screened chassis is mounted on a mahogany baffle board 610 mms. by 460 mms. having an over-all depth of 165 mms. The receiver

may be stood on the floor or a table, or hung, like a picture, on the wall. Almost perfect reproduction is obtained, which was previously only secured with an amateur constructed baffle board 1,120 mms. square.

Portable receivers are better than pre-war owing, of course, to the development of midget components.

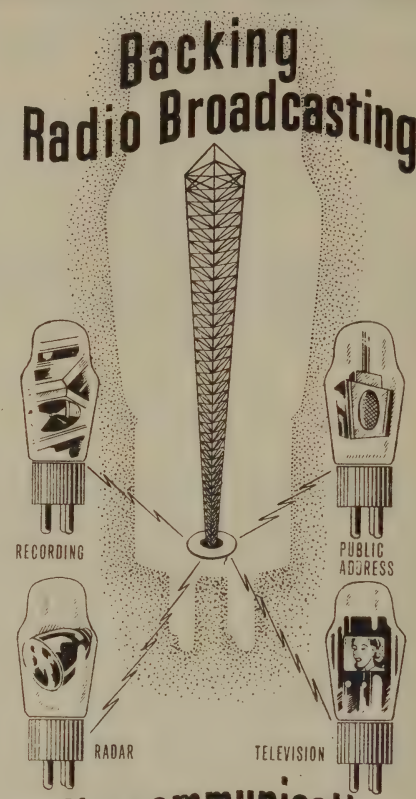
Dry batteries for both L.T. (Low Tension) and H.T. (High Tension) are used and have an approximate useful life of 200 listening hours. They operate special small-type economy valves which consume 0.05 amps. at 1.4 volts on the filament.

Weight has been reduced, due to the wider use of plastic and aluminium. The gross weight of most portables varies between 5½ to 8 kgs.. The latest portable, attracting considerable interest in Britain, is a four-valve personal receiver which can be slung over the shoulder like a hand bag, and has been developed from high speed wireless telegraphy sets dropped by parachute from Allied aircraft to Underground Resistance Movements in Europe during the war. The total weight, with a battery, is only 2 kgs., and the aerial, an external type, is wired in the form of a shoulder strap and is covered with black P.V.C. (polyvinyl chloride) plastic. P.V.C. (which is a wartime development) possesses high insulating and mechanical properties and was introduced in Britain during the war as a substitute for rubber.

The case of this personal receiver measures 230 mms. by 140 mms. by 50 mms. deep and is made of metal finished black ripple with chrome relief. Midget components of the types used in military tanks and aircraft are employed, while the valves of acorn size are of the type used in proximity fuses in anti-aircraft shells during the war, in conjunction with Radar. This set is neither a freak nor a toy. It has 14 stations on the tuning dial, and will receive others. The L.T. battery has a useful life of five hours and the H.T. 30 hours. The first introduction of this receiver to the public was at the "Britain Can Make It" Exhibition held recently in London. Plans are in an advanced stage in Britain for the manufacture of even smaller receivers, which will be accommodated in the coat pocket.

The outstanding features of the latest car radio receivers are: high quality of reception and tone; compactness of design and ease of installation. Single-bolt fixing is common, while one receiver is designed to fit into the glove box adjacent to the car instrument panel. This receiver has a special pre-setting device, whereby six pre-selected stations can be received at will by the motorist through the simple operation of a positive action rotary switch. Pre-set stations can be altered as necessary. Therefore, before proceeding on a journey the motorist can pre-select six programmes, select and switch any one, without stopping the car or diverting his attention from the road.

Car receivers generally have four valves plus rectifier, will receive both long and medium wave stations and operate through a DC/AC (Direct Current/Alternating Current) vibrator pack from the car's 6 volt or 12 volt battery. Battery drain is approximately 4 amps. on 6 volts and 2 amps. on 12 volts. Separate ignition suppressors have been dispensed with on these receivers produced in Britain, since input filter, aerial filter and double screening are employed.



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THIS "DX-ING"

STATIONS TO BE HEARD

HAITI:
HHCM.—P.O. Box 118, Port-au-Prince.
HH3W.—P.O. Box A-117, Port-au-Prince.
HH2S.—Societe Haitenne de Radio-diffusion, P.O. Box A-103, Port-au-Prince.

HONDURAS:
HRN.—"La Voz de Honduras," Tegucigalpa.

HONG KONG:
ZBW.—Hong Kong Broadcasting Committee, P.O. Box 200.

HAWAII:
KRHO.—P.O. Box 3740, Honolulu.

ICELAND:
TFJ.—Icelandic State Broadcasting Service, P.O. Box 547, Reykjavik, Iceland.

IRAN:
EPB, EQB, EQC.—Ministere des Postes, Telegraphes et Telephones, Administration de TSF Pahlevi, Teheran Iran.

INDIA:
VUB.—Office of the Station Director, All India Radio, Bombay, India.
VUC.—Office of the Station Director, All India Radio, Calcutta, India.
VUD.—Office of the Station Director, All India Radio, Delhi, India.
VUM.—Office of the Station Director, All India Radio, Madras, India.

JAMAICA:
ZQI.—2 Seaview Avenue, Half-way Tree, Kingston, Jamaica, B.W.I.

KENYA:
VQ7LO.—Cable and Wireless, Ltd., P.O. Box 777, Nairobi, Kenya, Africa.

LEBANON:
FXE.—"Radio-Levant," Forces Francaises Libres au Levant, Beirut, Lebanon.

MARTINIQUE:
Radio Martinique, Boite Postal 136, Fort-de-France, Martinique, Antilles Francaises.

MEXICO:
XEQQ.—Marroquil No. 11, Apartado 950, Mexico City, Mexico.
XEBR.—Apartado Postal 68, Hermosillo, Sonora, Mexico.
XEWI.—P.O. Box 2874, Mexico, D.F.
XEBT.—Apartado Postal 7944, Mexico, D.F.
XEFT.—Avenue Independencia 28, Vera Cruz, Mexico.
XEUW.—Avenue Independencia 98, Vera Cruz, Mexico.
XEXA.—Secretaria de Educacion Publica. Mexico, D.F.
XEUZ.—Apartado 2641, Mexico City, Mexico.
XEWW.—Apartado 2516, Mexico City, Mexico.

MOZAMBIQUE:
CR7AA, CR7BE, CR7BD.—"Radio Club de Mazambique," Caixa Postal 594, Laurenco Marques, Mozambique.

MIDDLE CONGO:
FZI.—"Radio Brazzaville," Poste National Francaise, Brazzaville, Middle Congo, French Equatorial Africa.

NEWFOUNDLAND:
VOHN.—The Broadcasting Corporation of Newfoundland, Newfoundland Hotel, St. Johns, Newfoundland.
VONF.—Newfoundland Broadcasting Corporation, St. Johns, Newfoundland.

NICARAGUA:
YNQ.—"La Voz de la Victor," Albert Solis L., Director, Apartado 338, Managua, Nicaragua, Central America.

PERU:
OAX1A.—"Radio Delcar," Saenz Pena No. 109, Casilla No. 9, Chiclayo, Peru.
OAX1B.—"Radio Piura," Castuls Casteneda-Administrator Director, Apartado 149, Piura, Peru.
OAX5A.—"Radio Universal," Avenida San Luis, Ica, Peru.
OAX4J.—Casilla 116, Lima, Peru.
OAX4T, OAX4Z.—"Radio Nacional," Petit Thouars 447, Lima, Peru.
OAX4P.—Apartado 187, Huancayo, Peru.

PANAMA:
HP5A.—"Radio Teatro," Apartado 954, Panama City, Panama.
HP5K.—Apartado No. 33, Colon, Panama.
HP5G.—"Emisoras HP5G," Apartado 1121, Panama City, Panama.
HP5B.—P.O. Box 910, Panama City, Panama.

PALESTINE:
Near East Broadcasting Service, Jaffa.

PORTUGAL:
CSW6, CSW7.—Ministerio Das Obras Publicas E Cominiaces, Emissora Nacional de Radiodifusao, Rua Do Quelhas, Lisbon, Portugal.
CS2WD.—Radio Renascena CS2WD, Rua Capelo 5, Lisbon, Portugal.

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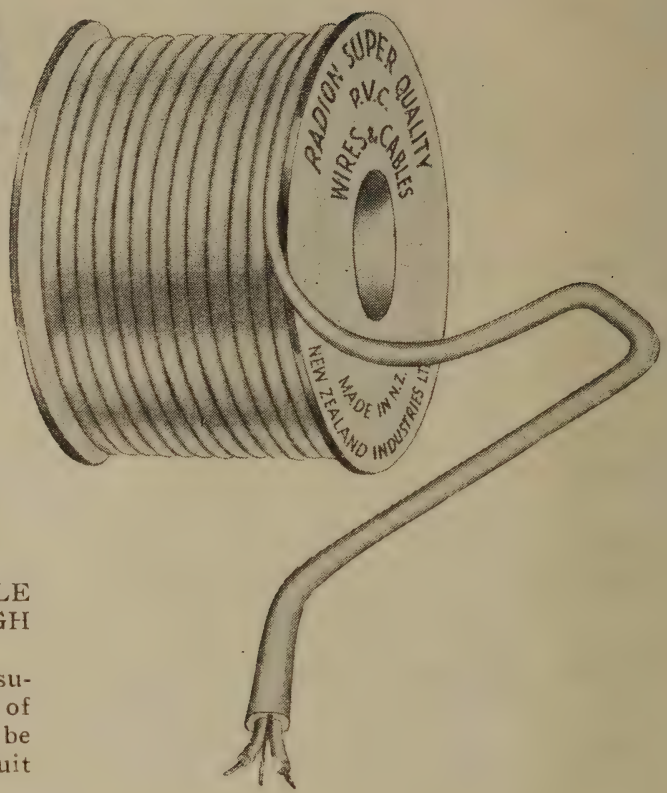

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Twin Flat 3/.036in.	0.003 sq. in.	1/.044in.
Twin Flat 7/.029in.	0.0045 sq. in.	3/.036in.
Twin Flat 7/.036in.	0.007 sq. in.	7/.029in.
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OUR GOSSIP COLUMN

Lalor Shiel, of Radio Service, Ltd., Dunedin, has recently paid a visit to the Capital City.

Lalor is one of New Zealand's really well-known radio engineers, and is now operating a modern and complete radio factory in Dunedin. He became prominent in the radio world when, some years ago, he designed and constructed some of the transmitting and receiving equipment for the Byrd Antarctic Expedition and worked in conjunction with the Bureau of Standards' Research engineer who accompanied the expedition.

About the same time, Lalor also constructed the transmitting equipment for the Norwegian whalers, the Sir James Clark Ross and the C. R. Larson. This particular equipment enabled the whalers to communicate direct with Norway.

An enthusiastic "ham," Lalor was one of the old identities in that field, and operated his station under the call sign of 4AK.

* * *

"Mac" McDonald, radio and electrical dealer of Te Aroha, called in to pass the compliments of the day. He commenced business prior to the War, and after seeing Army service (in particular ZC1's) he has returned to business and is now making up for lost time.

"Mac" tells us that he was referee for the Radio Ltd.—Akrad football match. Oh, brave man!

* * *

Our fame for sound advice is spreading—you will remember that in our last issue we suggested that Norm Swann should find a new "technique." Believe it or not, Norm has purchased a new "nag" and named it "Unique," no doubt prompted from the Latin "unus," meaning "one," and "equus," meaning "horse."

* * *

Radio dealers seen doing a spot of Christmas shopping in Wellington recently were Messrs. Fleming, of Matamata, and Lloyd, of Napier Battery Co.

* * *

Ralph Dixon, of Hamilton, has specialised in sound for many years, and is well known at all race meetings in Auckland, North Auckland, and the Waikato. At present Ralph is busy installing special sound equipment at Epsom which has been necessitated by the introduction of photo-finsh. The gear concerned utilises ordinary microphone and speakers, but is designed to operate as an elaborate talk-back system. The equipment will give instant two-way communication between the judges, totalisator, and P.A. announcer.

Although Ralph has been associated with races for many years, he tells us that he knows very little about horses—in fact, he says that, to him, a horse is merely a sort of animal with a leg in each corner!

* * *

Rev Grover, chief of Hohner Electrical Co., and Mrs. Hohner spent Christmas and New Year at Mercury Bay, where they enjoyed a well-earned rest.

The last few months have been full of activity for them as Rev has been building a ten-foot motor-boat, which he took with him. We can quite understand how he transported the boat to Mercury Bay—merely by strapping it to a trailer—but we are sorely puzzled to discover the means by which he transported the anchor, which, according to eye-witnesses, was approximately three times the size of the boat.

* * *

Rex Lulham, of National Carbon, is again ill, and unfortunately it may be some time before he returns to the office. We wish him a speedy recovery and trust that he will be back in harness in the very near future.

* * *

Charles Hart, also of National Carbon, has returned to New Zealand after being in Australia since September 26. He attended a District Managers' Conference in Sydney, where discussions were held with reference to general plans and advertising. When business was concluded, Charles and Mrs. Hart journeyed to Melbourne—the old home town—where they spent some time on vacation.

* * *

Bob Unwin, Chief Scientific Officer of the Canterbury Project, was married last month—to be exact, the balloon went up on December 20. We wish Mr. and Mrs. Unwin every happiness for the future.

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A Practical Beginners' Course

PART 7

The next circuit we are to build is that of Fig. 8. This is identical with the set of Fig. 7, except that L_1 and C_1 have been added. You will remember that in our description of how the crystal set worked, we noted that the coil and the variable condenser made up what is called a **tuned circuit,** whose job it is to **select** a station at the **frequency** to which it is tuned, and, at the same time, to reject all other stations on different frequencies. Since then we have looked into various ways of improving the selectivity of simple sets, finishing with the circuit of Fig. 7, which is easily the most complicated one we have yet tackled.

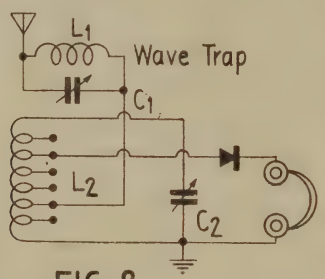

FIG. 8

In Fig. 8, the new tuned circuit, which has been called L_1C_1, has been put in especially for the purpose of making the set more selective at one particular spot on the dial. The new tuned circuit is called a wave-trap, because it is able to **trap** a signal and help to prevent it from getting through to the rest of the set. It is very useful when there is one particularly strong local station which manages to make itself heard all over the dial, even when the more selective circuits are being used.

The wave-trap is operated by tuning it to the frequency of the interfering station, and leaving it set. Although it will not remove the unwanted station altogether, it will greatly reduce it, especially when the tuning condenser C_2 is adjusted so as to receive another station.

L_1C_1 should preferably have exactly the same specifications as L_2C_2. That is to say, the variable condenser should be of the same type as that used for C_2, and the coil should be wound on the same kind of former, using the same wire, and the same number of turns as for L_2. As the circuit shows, it need not be tapped. If you have kept the coil originally wound for the first sets we built, this may be used, so that all that needs to be bought is the extra tuning condenser. It is a simple matter to mount the wave-trap coil and condenser on the base-board and connect them up, as in the circuit of Fig. 8, between the aerial terminal and the aerial alligator clip.

HOW TO OPERATE THE WAVE-TRAP

First of all, short-circuit the wave-trap with a piece of wire, and thus reduce the circuit to exactly that of Fig. 7, which we have already learned to operate. Then, using the crystal and aerial taps usually used before the wave-trap was added, tune in the unwanted station with the tuning condenser C_2.

Now, remove the short-circuit from the wave-trap, **and, without touching C_2,** carefully turn the wave-trap condenser C_1. At some point (which is often very sharp, and not easy to find if the condenser is manipulated too quickly), a sharp drop will occur in the volume received from the station. C_1 is now set at the position which gives minimum volume, and is left in this position. If now the set is tuned in the usual way (using C_2) to another station, it will be noticed that the interference from the unwanted station has been greatly reduced. It is a good plan, after tuning in the desired station, to readjust C_1 slightly, if its effect is not perfect, because there will always be a little inter-action between the two tuned circuits. If there is, the original setting of C_1 will have to be altered slightly to find the position which gives the best rejection of the unwanted station. However, with the circuit of Fig. 8, there should be very little inter-action between the controls as long as the aerial lead is not tapped too high up L_2. If the wave-trap was used with the simple circuit of the first set, which was without either aerial tappings or aerial coil, the inter-action between the controls would be quite serious, and moving C_1 would alter the tuning of the set to the wanted station.

Since there is usually only one very strong station which has to be eliminated with a wave-trap, it is not necessary to alter the setting of C_1 at all after the original adjustment has been made. It will be found that the presence of the wave-trap will hardly affect the strength of the signals received from stations other than the one it is tuned to reject.

OTHER CIRCUITS

If you have two identical tuning condensers, as suggested above, there are a number of more complicated crystal set circuits that can be tried. A good one is shown in Fig. 9, and can be constructed using the tapped coil, the two tuning condensers and the original coil with its aerial winding. The only extra component is the small unmarked condenser, which we will discuss later.

An examination of Fig. 9 shows that this set has two tuned circuits L_1C_1 and L_2C_2. It therefore has two tuning controls, C_1 and C_2, which must each be tuned for best results on the station which is to be received. The set can be laid out in any convenient manner on the base-board, but L_1 and L_2 should not be placed too close together. If this is done, there will be inductive coupling between them. This would be in order under some circumstances, but in this case the only coupling that is wanted between the two coils is the capacitative coupling given by the fixed condenser. A good plan is to mount the two coils so that their axes are at right-angles to each other. For instance, with one coil mounted vertically, as in our original set, the other

could be mounted horizontally. This can be done by making a small angle-bracket about four inches high and half an inch wide, to which the mounting lugs of the coil are screwed, mounting the coil in a horizontal position. Alternatively, a piece of wood could be used for the same purpose.

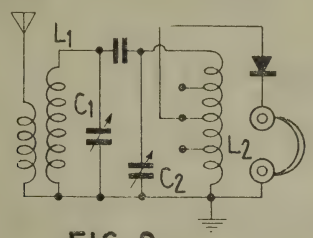

FIG. 9

You will remember that when we described the first crystal set, it was recommended that the rotor or moving vanes of the condenser (which are always attached to the condenser frame) should be connected to the earthed side of the coil. In the circuit of Fig. 9, it is quite important that both tuning condensers are connected this way round.

The fixed condenser on Fig. 9 should be very small in value—not greater than 0.00005 mmfd.—if good results are to be obtained with this circuit. The smaller this condenser, the smaller is the coupling between the two tuned circuits. If too great a value of coupling condenser is used, no benefit in the way of extra selectivity is obtained from using the two tuned circuits rather than just one. L_1C_1 in this set is not a wave-trap, as it is in Fig. 8, but is part of the set proper. Its purpose is to increase the set's selectivity. It does this by the simple process of adding to the selectivity of the second circuit C_2L_2, and its action can be explained thus: Suppose that in the aerial we have equal signals from two stations, one of which is wanted and one of which is not required to be heard when the set is tuned to the first. Suppose, further, that the tuned circuit L_1C_1, when properly tuned to the wanted station, causes the interfering station to become only half as strong as the desired station. The two signals are now passed to the second tuned circuit L_2C_2, which is also tuned to the wanted station. This circuit will now reduce the interfering signal to half the strength that it had after passing on from L_1C_1. Since, at this stage, the interfering station was only half its original strength, it is now only half of this, or a quarter of its original strength, so that the second tuned circuit has weakened the undesired station still further, while allowing the wanted station to pass through quite readily.

From this description of the working of the circuit, it can be seen that L_1C_1 and L_2C_2 must be tuned simultaneously to the station it is desired to receive, so that the two tuning condensers must always be manipulated together. This set is not really as satisfactory in some ways as the set of Fig. 8, which has the wave-trap, but it is an interesting one with which to experiment. The illustration it gives of two tuned circuits working together is most important, because it is only a very small step from Fig. 9 to a simple two-valve set, and we will have occasion later to refer back to this circuit.

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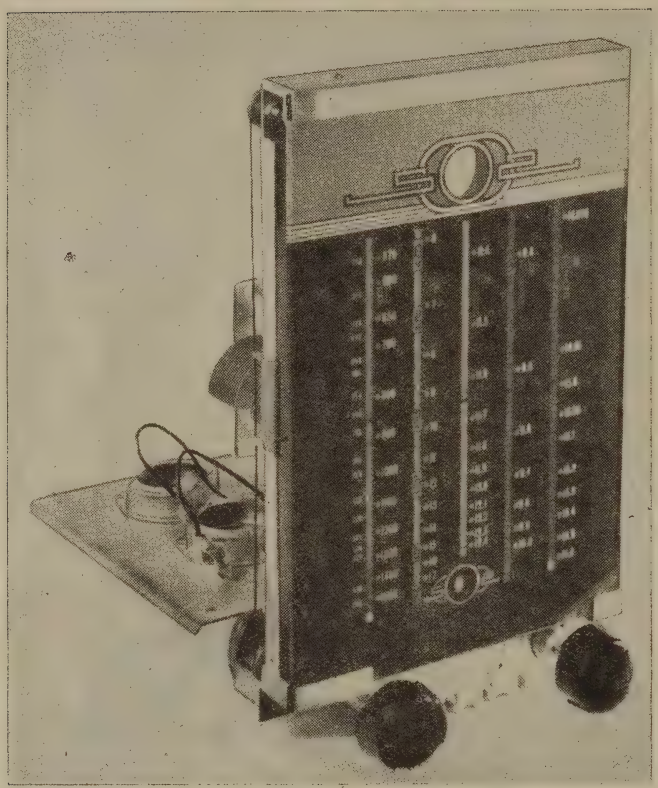

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THE SERVICE SECTION

PRACTICAL TROUBLE-SHOOTING—Part I

By C. R. LESLIE, late Technical Officer, Royal Aircraft Establishment.

In this series of articles it is proposed to confine our attention principally to the practical aspects of fault-finding from the serviceman's point of view, though it is hoped that they will also be found to be of interest to the amateur enthusiast who wishes to maintain his own receiving equipment. Therefore, it will be assumed that the reader possesses an adequate knowledge of radio theory and is familiar with the conventional types of circuit as used in "straight" and "super-het" domestic receivers. Radio theory will be introduced only where it is essential for the explanation of the operational principles of certain special circuit features. It is felt that this system will be the most direct one for carrying the reader smoothly along the path of the practical technique of trouble-tracing.

But, before dealing with practical tricks, it will be as well to consider briefly the stage properties required. It is not a matter on which definite rules can be laid down, as the subject is very much a case of "one man's meat . . ." Much **CAN** be done with the simplest of tools in experienced hands, but on the other hand, better and quicker work can be accomplished with proper tools. In normal times (and these are not very far away, we hope), there is a wide assortment of commercial test units available from which to select, and at varying prices and of differing degrees of accuracy. In fact, the position is analagous to that of the angler's catalogue, from which one can clutter oneself up with a multitude of lovely gadgets which would require a van to cart round and only a sprinkling of which one would normally use! It is hoped that the following short survey will be of some assistance to the reader who is in the market for test equipment.

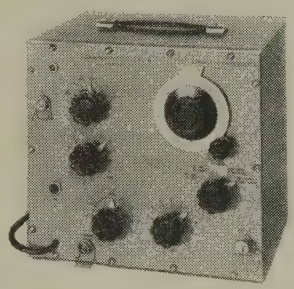
CHOICE OF TEST EQUIPMENT

Practical trouble-shooting falls naturally into three main stages: (a) The approximate localisation of a fault, (b) the exact diagnosis of the particular fault and its remedy, and (c) the final re-alignment of the receiver. The latter two stages are the ones that chiefly demand the use of good instruments. The faults which most commonly upset the operation are: Incorrect voltages and currents due to open and short circuits of components; partial leakages or faulty valves; the misalignment of tuned circuits; and loudspeaker faults.

THE SET ANALYSER

Commercial "set analysers" are available to provide tests to cover all of the above symptoms, as they incorporate several ranges of resistance, A.C. and D.C. voltage and current measurements, valve-testing circuits to cover a very wide range of valve types for "goodness" as well as for high-resistance leaks between electrodes, and also capacity measurements and condenser-leakage tests. By using a low voltage range the equipment may be used as an output meter.

On the face of it, one of these instruments should cover the bulk of our needs, but there are other points to be considered. The equipment is somewhat bulky for carrying about or moving about the test bench. Also, we are rather putting all our eggs into one basket—quite often we shall want to have the meter in more than one place at once, as, for instance, when taking current or voltage readings at one stage while making simultaneous output measurements. Admittedly, such an instrument forms a handsome piece of furniture on the test bench quite apart from its many uses, but it would be advisable to have two or three separate units of compact and portable construction so that we can take two or three simultaneous readings from different points in the circuit. In any event, we should have at least two multi-range meters in case of accidents; meters **DO** go wrong, and usually make a point of doing so when one is particularly pressed for time.



A typical signal generator of high quality. This instrument has an extremely good attenuator, calibrated in microvolts, and covers 100 kc/sec. to 30 mc/sec.

MULTI-RANGE METERS

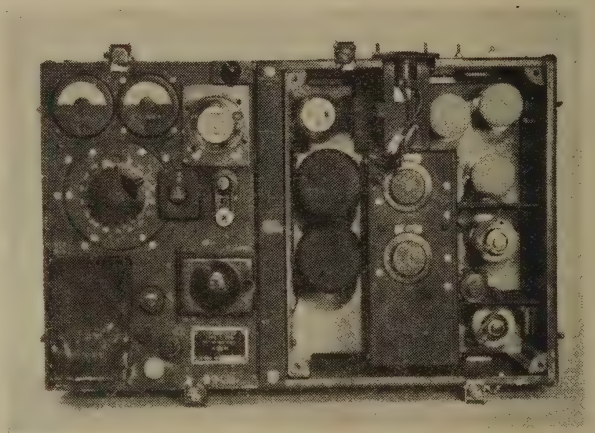
The majority of our testing will be normally confined to voltage, current, and resistance measurements, and these can be catered for in a much more compact form as a multi-range test meter—a good example of the type is illustrated here. When selecting such a meter, the main points to be borne in mind are: (1) Reliability of manufacture, (2) the scope of the ranges provided, (3) a good open scale for quick and accurate reading, and (4) high ohms per volt movement—this last should not be **LESS** than 1000 ohms per volt. This standard will be found to be quite sufficient as well as convenient for our purpose, as many servicing data are published on this basis; our readings have only to agree with the data to be correct, and will not necessarily give accurate measurements, owing to the power absorbed by the instrument. A meter of this type should certainly be considered as one essential basic unit.

THE SIGNAL SOURCE

The next most important item is a calibrated signal source for the injection of audio-modulated or unmodulated radio frequencies or of a separate audio frequency into the circuit at various points for general fault location without dependence on broadcast signals, and for the accurate alignment of the receiver. The signal generator should have optional 400 c/sec. modulation on all ranges from 100 kc/sec. to at least 20 or 30 mc/sec. It is preferable to have one that is mains-operated, as the calibration will hold its accuracy much better. For choice, the

TRANS - RECEIVERS

This ex-Air Force T.R. 9 transmitter receiver was designed for use in air communication. The transmitter is a M.O.P.A. consisting of a crystal oscillator and a pentode P.A. stage. A pentode modulator plate modulates the P.A. stage. In the T.X. position speech amplifiers are the audio stages of the receiver. The T.X. contains an R.F. ammeter and a plate milli-ammeter. The frequency range is 4.3 to 3.6 mc/sec. The complete set is intended to be powered by a 120v. "B" battery and a 2v. "A" battery. The T.X. draws 28 milli-amps, and considerably less on R.X.



The condition of the valves cannot be guaranteed, but, for battery operation, suitable pentode and triode tubes of the 1½ or 2 volt series may be used. Likewise, for A.C. operation, standard 6.3 volt tubes of a suitable type may be used together with a conventional power pack.

It would be necessary to rewind both transmitter and receiver coils for 20, 40 and 80 metre bands. In addition, it would also be necessary to wind an aerial coil for the receiver bands, as at present the receiver input and transmitter output are common.

In addition it will be necessary to modify the oscillator circuit as no crystals are provided with the set.

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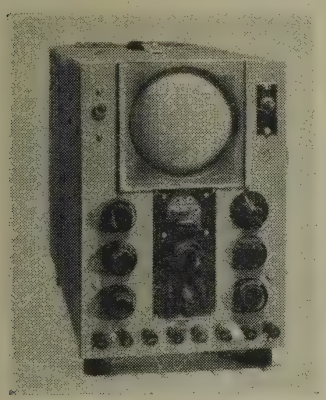
output waveform should be as free from harmonics as possible. The instrument should incorporate an attenuator system whereby the output amplitude may be varied by regular steps and by variable amounts between each two steps, from a few microvolts up to at least one volt. The generator is, in fact, a miniature fully-screened transmitter, and, as such, is usually supplied with dummy aerials for broadcast and shortwave ranges respectively. It is an advantage to have means of using the 400 c/sec. signal separately for the testing of the LF section of a receiver.

Much can be done with these two units, which should form the minimum "bare bones." If this equipment is to be the base, it should be a **GOOD** base and thoroughly reliable, so it is advisable to purchase such kit **NEW** and of a well-known and dependable make. For convenience, it is recommended to duplicate the "ohm-volt-am" meter, which could be purchased second-hand if desired, as its calibration can be checked against the standard. The best meter should remain in the workshop, while the other does the travelling and the rough tests.



An excellent commercial type of oscilloscope, which has incorporated in it practically every possible facility, even to optional electro-magnetic deflection coils.

We would be inclined to add a third item as an "essential" — though the title is not strictly accurate—and that is a good pair of earphones. Their use can be made so handy and quick for rough fault location, either at the bench or at the customer's house, that they well deserve a position in the serviceman's "cabinet."

THE OSCILLOSCOPE.

After the "essentials," we come to the desirable additions, and pride of place must be given to the oscilloscope. It will serve as a valve voltmeter for the comparative measurement of RF voltages, since it possesses a very high input impedance and a very low input capacitance. Similarly, it may be used as an output meter. It will also be found invaluable for the "precision" method of visual alignment of receivers, as it forms the readiest means of any for this purpose. But for this work it is essential to use a frequency modulated signal generator—the ordinary service type of generator can be used with the addition of a "wobbulator" unit to vary the radio frequency on each side of a datum by some 15 kc/sec., to lock with a 25 c/sec. sweep on the horizontal deflection plates. Ready-made commercial oscilloscopes are available, but are somewhat expensive. An excellent practical design for a service instrument was given in these pages in the May-June-July issues, 1946.

The oscilloscope also carries a psychological advantage in that to the uninitiated it is a real "magic box" and customers are usually deeply impressed by seeing it in use and mentally promote you to a "super" rank!

VALVE-TESTERS

Somewhat in the same class of psychological usefulness is the valve-tester. For his own work it cannot be called a necessity, for if a fault is definitely traced to a valve the normal practice is to replace the offending member without further ado, but the serviceman may find it extremely advisable to possess this gear for the benefit of his customers, who will often want it proved to them in some visible manner that the valve is really faulty, or may wish to have their valves tested for them. For this service, a small nominal charge could reasonably be made.

There are several types of testers commercially available, and usually fitted with meters calibrated as "good—?—bad." Those that check a valve from its mutual conductance value are to be preferred to those that rely on emission tests only. They usually provide for the testing of rectifiers and power valves by emission tests, as well as incorporating some means for testing the insulation between electrodes and for showing up leaky condensers. Some forms include the multi-range meter, and have already been referred to as "set analysers."

OUTPUT METER

An output meter forms a very desirable addition to the family because of its sensitivity and compact size. It can be used simultaneously with the multi-range meter when voltages or currents require to be read at another point in the circuit. The output meter should be provided with a multi-ratio input transformer for matching to both high and low impedances, in addition to a calibrated attenuating potentiometer across the secondary.

AUDIO SIGNAL SOURCE

For the servicing of P.A. or other audio amplifiers, we shall require a second signal generator with a frequency range from 20 c/sec. to some 20 kc/sec. Like its R.F. cousin, it should incorporate a calibrated output attenuator. Most important of all, the output waveform should be as nearly a pure sine wave as possible, as it will not do to inject a distorted waveform if we are searching for the cause of distortion! Commercial instruments are often constructed on the B.F.O. principle, and a good instrument is rather pricey because of the precautions taken for purity of output. For less accurate work, such as the taking of response curves with fair accuracy, the construction of a serviceable generator is within the scope of the average home constructor.

CAPACITY BRIDGE

Lastly—although by no means an essential—a very useful possession is a good resistance-capacity bridge, which should be mains operated. It should be capable of measuring resistance from a fraction of an ohm up to some 10 megohms, and capacities from a few mmf. up to some 10 mf. Some commercial bridges also include inductance ranges for the checking of R.F. coils. This addition rather complicates the construction, and hence is a good deal more expensive to buy.

It is hoped that the foregoing will assist the

reader in separating the sheep from the goats and enable him to decide on the furniture for his own particular needs. But before discussing the practical use of these instruments, we would like to say a few words about the use of a system of procedure for general trouble-tracing.

THE VALUE OF SYSTEMATIC PROCEDURE

Since the two main factors, from the point of view of business economics, are **SPEED** and **EFFICIENCY**—speed to reduce working costs, and efficiency for customer satisfaction—it is obvious that the development of a system which will localise and detect faults in the quickest and most direct way is extremely important. It may be argued that to adhere to a system when a fault is immediately obvious is a pure waste of time. Admittedly this would be true if the word merely referred to the method of making point-to-point tests throughout the receiver. "System" is intended here to be used in a much more elastic sense—in other words, to have a system of using systems to meet all general cases.

CLASSIFICATION OF FAULTS

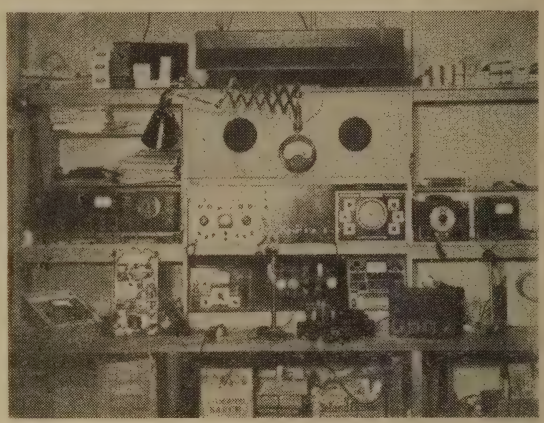
For instance, it will be found in practice that individual models and makes of receivers often tend to develop certain distinctive faults. In the course of our work we shall undoubtedly encounter a wide variety of makes of many vintages, and it is sound practice to maintain special files for each. Each file should include a circuit diagram of the set as originally wired, together with collected data of fault symptoms and the remedy that was found to be required, as it is quite impossible to memorise all these over a period of some years and dozens of different makes and models. Thus, when a set comes in which is amongst our entries, the chances are that we shall find that a similar symptom was encountered previously and we shall immediately know what fault to look for and what remedy to apply, and this solution may be the required answer. The file could be extended with advantage to include a maintenance sheet for each particular model, commencing with the date of first acquaintance and followed by details of the servicing provided afterwards. The primary entry should be as complete as possible anent the previous history. Such a sheet is often useful for proving to a customer that later faults are quite separate from those formerly remedied and are not due to any previous negligence on your part.

QUESTIONING THE OWNER

Then we require some method in the manner in which to question the owner about the symptoms, length of time since the set had received any servicing, the average amount of time daily in which it is in operation, and so on, in order to extract every detail that may be of assistance in the quick location of the defect. Usually too much reliance cannot be placed on the accuracy of the symptoms' description, but the more you can get the owner to talk, the greater the chances of picking up verbal signposts of real value. This is not wasted time, as the conversation is carried on as a background while you play with and inspect the set—and you secure the owner's goodwill by your show of interest and you seal it with a little bit of butter about the great help he has afforded you by the clearness of his explanation.

It might be found to be a sound policy to keep two pads; on one of them mark a date about a month later than that of the delivery of the repair, putting down sufficient data to enable you to recall the work to mind. On this date you ring up and inquire whether the set is still giving full satisfaction. The call leaves a good impression in the customer's mind. On the other pad you note a date about six months later, and on this date you ring up again and suggest that you call for the set to give it a once-over and retrim up to concert-pitch, as radios get out of tune just like pianos—you will let him have the set back the same day and there will only be a small nominal charge.

The above is put forward purely as a suggestion for a type of business system which will keep you in close contact with your customers. The creation and maintenance of customer confidence is the idea behind any such procedure, as it tends to produce further easy prospects sent to you by the customers themselves or through their chats with friends.



In response to our request for photographs from servicemen, the above was sent to us by Bruce Marshall, Tauranga Electrical Co., and we take much pleasure in reproducing it here. The workmanlike lay-out of the bench and its equipment can be readily seen, and is a credit to its owner. Among the test instruments are an R.C.A.-Rider Chanalyst, a Taylor Signal Generator, and University and Supreme instruments.

System is also required in the workshop, in the careful laying out of the bench and equipment, disposal of the components and tools so that there is no confusion or waste of time in hunting for items. Then we should plan our work as far as possible so as to clear the quick and easy repairs out of the way with the greatest dispatch to leave free time for tackling the bigger jobs and more obscure troubles. Plan the following day's work, where possible, just before knocking off in the evening and set out the work and gear ready for action first thing in the morning.

Admittedly all this is rather idealistic and is not likely to be adhered to in practice, as there are bound to be many interruptions of one sort or another during the day, and fresh sets coming in "wanted particularly by the evening," and so on. But matters will run more smoothly if we make a genuine attempt to work to some definite planned order.

(To be continued)

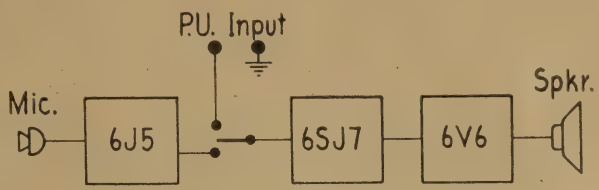
QUESTIONS and ANSWERS

Mr. F. W. Messenger, Omahuta, writes: "Could you advise me on a suitable tube line-up for a vibrator-operated amplifier for use at small meetings, etc. The vibrator pack will deliver about 180 volts at 40 mils. I have a good quality magnetic pickup and intended using a crystal mike. The only other information I would require would be the correct value of cathode resistors to use, as in most bias charts these are given for 250v. only."

The vibrator pack mentioned will be sufficient to supply tubes giving not more than 2 watts output. We do not know whether this is considered sufficient for your purpose, but, if not, a heavier-duty vibrator unit will need to be acquired.

Since tubes of the 0.15 amp. heater variety are difficult to obtain, the recommended output tube is a 6V6, which, with 180v. on the plate and screen, is capable of the above output, drawing 32 to 34 milliamps, and leaving the remainder for the resistance-coupled voltage amplifier stages.

The suggested line-up is given in the accompanying diagram. The 6J5 may be considered as the microphone pre-amplifier and need not incorporate a gain control, which can be in the 6SJ7 grid circuit, with a switch to provide a pickup input direct to this stage. The total heater drain is 1.05 amps., which is not excessive.



Block diagram of the recommended amplifier.

Operating conditions should be as follows:—

6V6	Plate load impedance	5000 ohms.
	Cathode resistor	250 ohms.
6SJ7	Plate load resistor	250k.
	Screen dropping resistor	1 meg.
	Cathode resistor	1000 ohms.
6J5	Plate load resistor	100k.
	Cathode resistor	2k.

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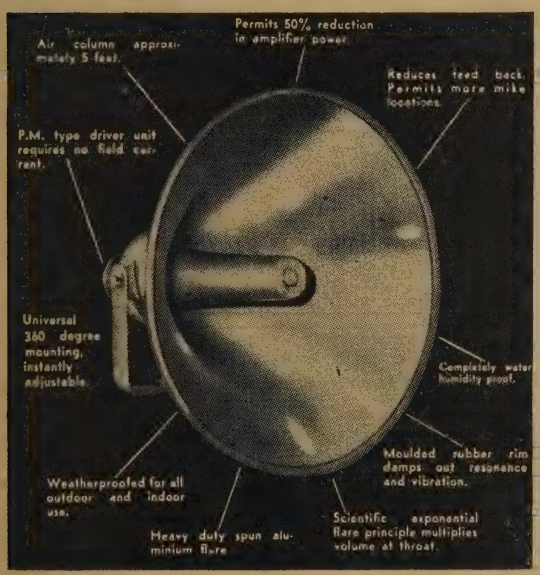
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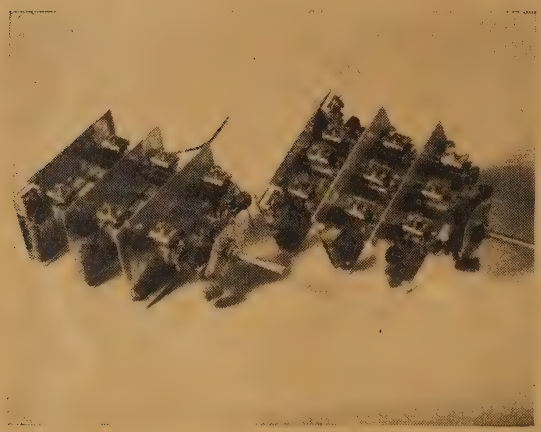

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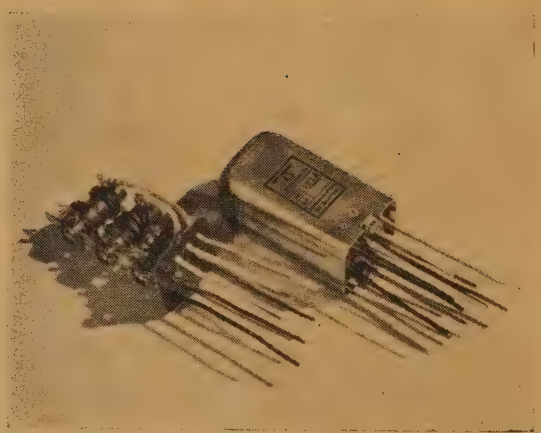
Type 14 Dual Wave Aerial and Osc. Stage .. .. £4 10s. 6d.
Type 34 Dual Wave Aerial, R.F. and Osc. Stage £6 7s. 2d.
Type 64 Triple Wave Aerial, R.F. and Osc. Stage £7 6s. 0d.

D.W. band coverage 540-1600 kc/sec., 5.75-20 mc/sec.
T.W. band coverage 540-1800 kc/sec., 1.75-6 mc/sec., 5.75-20 mc/sec.



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THE N.Z. ELECTRONICS INSTITUTE

NEWS OF THE BRANCHES

The Wellington branch held its November meeting on 13th of that month in the lecture hall of the Central Public Library. Mr. W. D. Foster, B.Sc., addressed the meeting on the subject of "Modern High-definition Television Systems." In his address, Mr. Foster outlined the fundamental problems involved in the radio transmission of television signals, and devoted some time to an analysis of the complex video wave-form. He concluded his lecture with a brief comparison between the British and American television standards, and a discussion of the factors involved in the introduction of television to New Zealand . The speaker expressed the opinion that it would be at least some years before New Zealand could expect to have its own television service, both because of the enormous expenses involved in providing programme material, and because there are, as yet, no international television standards. Not the least of the problems to be encountered here, said Mr. Foster, is that of the topography of the country in relation to the scattered centres of population.

* * *

The November meeting of the Dunedin branch was held in the Physics Department of the Otago University, and members were addressed by Mr. J. S. Coombs, whose subject was "Frequency Standard Measurements." A special feature of the evening was a demonstration of the principles and use of the Frequency Standard which has been constructed at the University.

* * *

The Christchurch branch held two meetings in November, the first being the usual monthly meeting. The feature of the evening was an address by Squadron Leader J. W. Todd, M.B.E., R.N.Z.A.F., on the subject of "Navigational Aids." The second meeting was a special one called for the purpose of discussing the proposals of a special committee which has been set up to consider the subject of Institute examinations. The branch was unanimous in adopting the committee's recommendations that the Council should introduce an Institute examination, appoint a Board of Examiners, and make the necessary arrangements for the conduct of examinations.

* * *

The Wellington branch, on receipt of the proposals of the committee, combined a discussion on the proposals with its normal December meeting. The following remarks were communicated to the Secretary by Mr. R. Slade, who was unable to be present, and as the discussion showed, were representative of the feelings of the meeting, which unanimously confirmed the proposals after some discussion. Mr. Slade's communication read as follows:—

"As I had intended to make some contribution to the discussion arising out of the proposed admission qualifications, I trust the following written comments will serve instead:—

"(1) The last war brought home to the Education Authorities and to Industry throughout the British Empire the blunt fact that the great acceleration in engineering progress completely outstripped the facilities available. One of the predominant factors was the lack of provision of adequate and proper training and educational facilities for engineers.

"Because of this realisation, we are now seeing, even in New Zealand, a somewhat revolutionary change taking place in the educational facilities available for the improved training of a larger number of technical engineering trainees.

"(2) If the accelerated engineering progress is to be utilised effectively, there is an immediate need for a widespread and co-ordinated expansion in our training schemes. This applies particularly to Electronics. Obviously, the Education authorities and Industrial management must co-operate much more than in the past, and between them must formulate the new educational requirements on to a new and higher technological plane.

"(3) Similarly, the trainees themselves, and particularly the existing qualified men in industry, the teaching profession, the various technical Government Departments, must move along in the same direction. For instance, in the radio industry, the radio serviceman's examination appears at the moment to be the only qualification generally aimed at by those trainees who desire to make Radio and Electronics their life work. That examination must be viewed more as a minimum compliance with a Public Works Department safety regulation, than as an indication of a radio serviceman's technical qualifications. Furthermore, the technical qualifications arising out of the present examinations are being increasingly depreciated in the eyes of industrial management, mostly because of a belated realisation that much higher qualifications are now needed for coping with the rapidly accelerating electronic art.

"Industrial management and the Education authorities are mostly to blame for this situation.

"(4) It is obvious, therefore, that there is an urgent need for a scheme which will elevate the standard of technological qualifications of present day and future trainees, and personally, I believe that the New Zealand Electronics Institute can fill a part of this gap. If the Institute, in spite of likely temporary opposition, starts off by fixing the various technical qualification grades at a high level, I firmly believe that, within a comparatively short time, it will gain strong support from both Industry and Government Departments and from Educational authorities also.

"Above all, it will set a target, at present non-existant, at which a trainee may aim with the knowledge that he can claim membership of a professional body whose status is high, and that he will be viewed by all as having reached a genuine and acceptable standard of technological achievement.

"(5) To those who would oppose the setting of high standards I would say this—the Electronic art is rapidly reaching the stage where only those who have the initiative and determination to acquire a high standard of education and technical qualifications will be acceptable to industry. Furthermore, the time has come to strive for an acceptance of our future electronic engineers as having professional status, instead of the present qualification of "skilled

"(6) We all want, and demand as a right, a reasonable standard of living and security of employment. Is it not logical that the higher the degree of our technical attainments, the better our standard of living becomes with correspondingly fewer fears of economic insecurity?

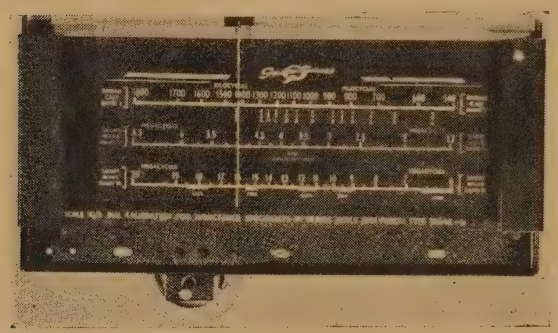
"It must be obvious to all that Government legislation during the last few years has most inequitably narrowed the gap in remuneration between the unskilled and the skilled man. Existing legislation tends to narrow that gap still further. In actual fact, this means that whereas the standard of living of the unskilled worker has undoubtedly improved, that of the skilled worker has seriously deteriorated by comparison.

"It seems to me that our skilled radio and electronic technical and engineering men have a duty to themselves to see that their status is raised to a level which will command a fair and reasonable remuneration consistent with the academic and practical qualifications involved, and that in self protection against present trends they must use every means in their power to place themselves outside and above the classification of 'skilled workers.'

"For the above reasons I strongly support the organisers of the New Zealand Electronic Institute in their proposals to formulate their member classifications or grades on appropriate examination bases.

R. SLADE."

DIALS!



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D/3—A small dial movement of similar design and construction to the type D/1, but not incorporating spin tuning. Designed to receive the glass edge lit scale type SC/3. Approximate outside measurements 6½in. by 5in.

SCALES:

SC/1—Dual Wave. Printed in two colours and calibrated to match our "A" series coils when used with the Plessy type 1842/11 condensers. For use with dial movement type D/1. Recommended inside escutcheon size, 8¾in. by 3in.

SC/2—Triple Wave. Printed in three colours and calibrated to match our "A" series coils when used with the Plessy type 1842/11 condensers. For use with dial movement type D/1.

SC/3—Broadcast. A single colour scale calibrated to match our "A" series coils when used with the small Plessy type 9372/L27 condenser. For use with dial movement type D/3.

INDUCTANCE SPECIALISTS,

202 Thorndon Quay, Wellington

LETTERS TO THE EDITOR

THE PROGRESSIVE THREE

Sir.—Having for some time been interested in small regenerative receivers using 1N5's and 1D8's, I was pleased to follow your series on the Radel "Progressive Three," which concluded in the December, 1946, issue of *Radio and Electronics*. I built the set according to instructions, except that I was unable to procure a 100,000-ohm potentiometer for R_{11}, and used a 250,000-ohm pot. instead. This was the only item at variance with your instructions.

When the set was switched on, I found that a small "train" had got into the works. This was a type of motor-boating, but much slower. The coupling condenser C_5 was replaced with one of .002 mfd. and the "train" vanished.

I was using an old horn-type speaker with adjustable diaphragm, and at 8.15, while it was still quite daylight down here, I heard 3YA, 4YA, 2YC, 4ZB, 3ZB, and the local station 4YZ at really good volume, besides several others which were just audible. The aerial was approximately 60 feet long and 22 feet high.

At 9.45 p.m., when it was quite dark, 2YA and 1YA were heard at between 60 to 80 per cent. readability, while 3YL, 4ZB, and 3ZB had to be turned down in volume. There were many stations all over the band at varying strengths. Tone was good and regeneration was very smooth.

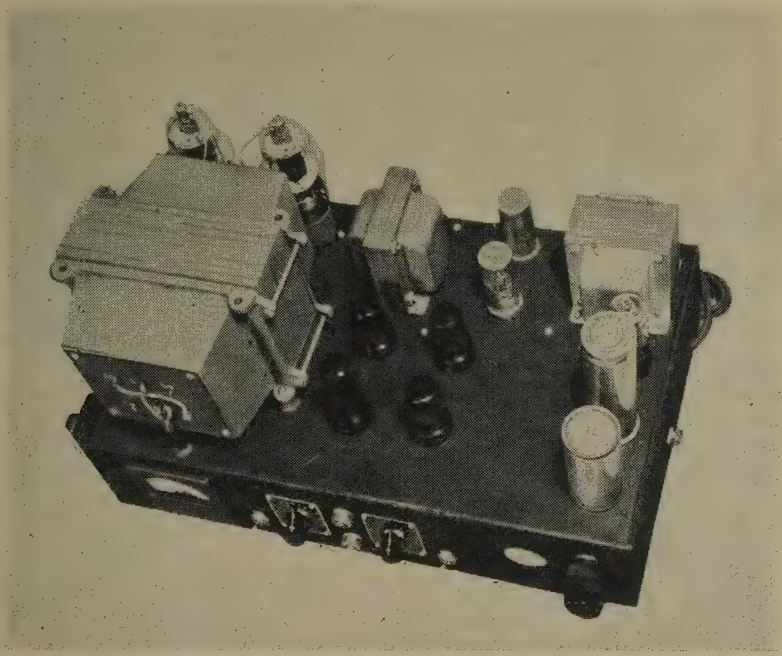
Could you inform me as to the reason for the "train" in the works with the .01 mfd. in C_5, and whether I am losing anything in performance by using a .002 in its place?

You stated at the conclusion of your article that you would be pleased to hear from any reader who built this little set, so I trust that this letter will be of interest to you. I am very thrilled at the performance I have obtained from it so far, and the ease of operation and degree of stability are far ahead of anything in this line with which I have previously experimented.

Thanking you for a very interesting little set and congratulations on the best radio magazine procurable. Long life to *Radio and Electronics!* —I am, etc., S. M. RATTRAY, Staff-Sergeant, Signal Section, Area 12, Invercargill.

[First of all, we wish to thank Staff-sergeant Rattray for his interesting letter, and to say how pleased we are over the success of his "Progressive Three." The "train" referred to is a very low frequency oscillation, and has been cured in this instance by reducing the response of the audio section at frequencies below 10 c/sec. The decoupling filter tradesmen."

R_1C_2 was included so as to reduce the possibility of this form of instability, and in our prototype completely prevented the trouble. Reducing C_5 to 0.002 mfd. will have very little effect on the quality of the output, giving slightly less bass response, but having no other effect.—Ed.]



THE 50-WATT MODULATOR

Readers have requested that we print a photograph of the 50-watt 807 modulator described in the August issue of "Radio and Electronics." Here it is. Along the right-hand side of the chassis can be seen the C.R.T. power supply. The large transformer is the modulator transformer, behind which may be seen the 807's. Beside them is the driver transformer. In front of the latter are the 6J5 drivers, and in front of them again are the 6SJ7 and 6N7.

Along the front edge of the chassis are the plate current meter, then, in a group, the two input sockets, the two volume controls, and the power switches. At the right may be seen the face of the C.R.T. modulation indicator, and beside it the brilliance and focus controls.

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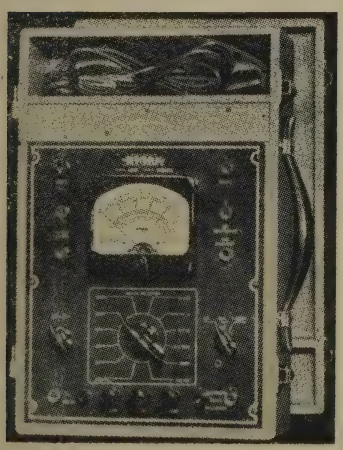

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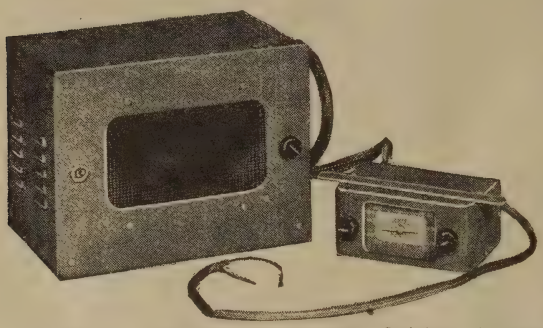

We now have kit-sets, wiring diagrams and constructional details for a 5-valve car radio which enables the home constructor to make a high-grade receiver equal in tone and performance to the imported radio.

It is made in two units—one, the small control unit, is COMPLETELY WIRED and may be fitted to the steering column or instrument panel. The second unit is the main assembly, and measures 9¾ in. x 7¼ in. x 6 in. The tube line-up, including an R.F. stage, is two 6SK7's, one 6K8, one 6Q7, and one 6V6.

By substitution of low-drain tubes, this kit would make an excellent set for boat or caravan. The two units are housed in metal cabinets handsomely finished in sprayed suede flock.

Prices for the complete kit of parts, together with further technical information, will be given on request. The following kits are also available:—

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A MULTI-CARRIER V.H.F. COMMUNICATION SYSTEM

(Continued from page 46)

are separated by distances never less than the range of a station. This offers interesting possibilities for broadcasting, and for communication with aircraft and trains throughout the length of their routes. Simple low-gain receivers without high frequency-stability could be used.

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The disadvantage of a.m. relative to f.m., as regards ignition noise, has been removed and may soon be reversed, by the use of suitable noise-limiting devices, and by pre-emphasis of the high modulation frequencies at the transmitter and de-emphasis at the receiver. In addition, a.m. has important advantages besides applicability to the multi-carrier system, for which f.m. seems to be impracticable. Receivers can be of a simpler type, requiring less maintenance, because precise frequency control is unnecessary, and for other reasons. F.m. transmitters, too, are more complex. One f.m. channel with a frequency deviation giving useful results occupies a frequency band that may be wider than the three used in a m-c a.m. system, especially as the carrier spacing for the latter is now being reduced to 12 kc/s, with a receiver bandwidth of 50 kc/s. A.m. is used by at least 37 separate police and other forces in Britain, with very satisfactory results. It can certainly not be assumed that f.m. is necessarily better for V.H.F. communication, even in a single-carrier system.

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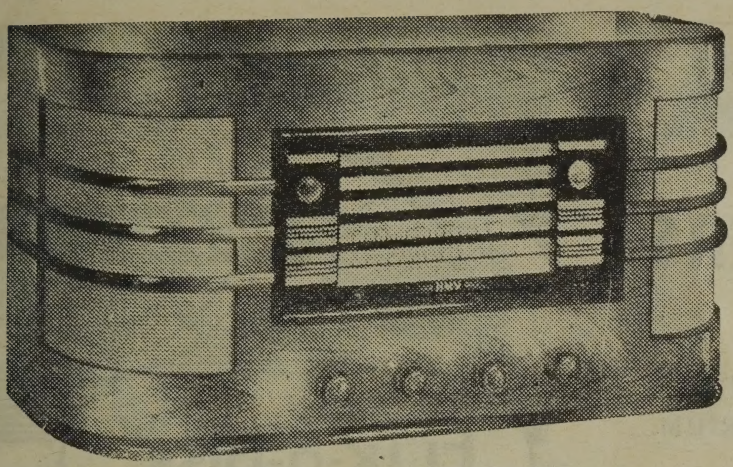

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PUBLICATIONS RECEIVED

The Cossor Model 339 Double-beam Oscillograph.
The Cossor Frequency Modulated Ganging Oscillator.

These two books are instruction manuals for two commercial equipments produced by Messrs. A. C Cossor Ltd., London. At least, that is their primary purpose, for it is noted on the back covers that one copy is supplied free with the instruments concerned, but that each book may be purchased for three shillings and sixpence (in England). This fact alone testifies to their excellence as general treatises, the first on the use of the oscilloscope, and the second on the visual alignment of receiver circuits. The fact that both are written with special reference to the Cossor instruments in no way detracts from their value in this respect. A great deal of the material is quite general in application, and will be of great interest to all concerned with radio generally and receiver alignment in particular. The style is concise and matter-of-fact. Any salesmanship, for example in the second booklet, is devoted to the method of visual alignment as such, rather than to the Cossor instrument for carrying out this method, the firm's good name being relied upon to recommend their particular version of the equipment, in addition to the demonstrable performance of the latter. We are advised by Messrs. Swann Electric Co., Ltd., New Zealand agents for Cossor, that supplies of these booklets will be available, and that all enquiries should be addressed to their Wellington office, P.O. Box 90, Wellington.

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(*Continued from page* 11)

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